SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1908.

GENERAL PHYSICS.

1034. *The Recording Sliding-balance, Snow, Rain, and Evaporation Gauge.* **A. Sprung.** (Meteorolog. Zeitschr. 25. pp. 145–154, April, 1908.)—The author comments on the improvements which the Sprung-Fuess gauge has undergone since it was first put up at Potsdam in 1892. Three such gauges are now installed there, the second 1·5 km W. of the first, the third 2 km N. of it. The instrument was originally intended as a snow gauge, but it records rain or snow by a rise in the curves which the style draws, and evaporation by a fall. Yet a small rise does not necessarily indicate a slight rain; for there may be an increase in weight owing to the condensation of dew or hoar-frost, and more frequently a slight rainfall may be balanced by evaporation. The plate on which the collecting vessel stands rides directly on the beam. The vessel is jacketed with a stationary shell which is inclined inward at the top, and a little annular apron hangs down from this conical rim. The mechanism was originally mounted in a double-walled hut, the inner wall consisting of corrugated iron, and the space between the walls being heated by gas; but the gas and condensed water corroded the iron, and the space was then merely packed with oakum and hay. H. B.

1035. *Strength of Chain Rings.* **G. A. Goodenough** and **L. E. Moore.** (Univ. of Illinois Engineering Experiment Station, Bulletin. Engineer, 105. pp. 497–499, May 15, 1908. Abstract.)—The original report is partly devoted to an analysis of the stresses in chain links, whose form consists of four or six circular arcs, approximating to an ellipse, and with various assumptions as to distribution of pressure of contact between adjacent links. Tests were made on circular rings of rectangular section, and also on several ordinary forms of link. It is concluded that the experiments confirm the analysis, and show that the distribution of contact pressure lies between the two extremes: (1) point contact, and (2) pressure concentrated at two points. For calculation, uniform distribution of pressure over a small arc may be assumed. With an open link of usual proportions, the max. tensile stress is approximately 2W/A, where W is the total load and A the area of cross-section of ring. The introduction of a stud diminishes the stresses in the link so long as these are within the elastic limit, the max. tension by about 20 per cent., and the max. compression by about 50 per cent. The ultimate strength of the stud link is probably less than that of the open link chain. The following formulæ are applicable to chains of the usual form: $P = 0{\cdot}4d^2s$ for open links, and $P = 0{\cdot}5d^2s$ for stud links. P is safe load, *d* the diam. of stock, and *s* the max. permissible tensile stress. F. R.

1036. *Manufacture of Compressed Gas Cylinders.* **C. Wadas.** (Stahl u. Eisen, 28. pp. 668–670, May 6, 1908.)—Describes the Erhardt process for making steel gas cylinders and tubes. A square ingot or bloom is placed in a round die, and a punch rapidly descends and makes it into a hollow cylinder closed at the bottom end. This is then hot-drawn through a series of dies, until reduced to the desired thickness of wall; when this is less than 5 mm. the metal is drawn cold. The remainder of the process differs little from usual methods. The steel employed for the cylinders has a tensile strength of from 50 to 55 kg./mm.², elastic limit about 30 kg./mm.², elongation 18 per cent. With the commonest size of cylinder, 130 mm. internal and 140 mm. external diam., 1,120 mm. long parallel, the proof pressure of 250 atmos. corresponds to a stress of about 30 kg. per mm.². This pressure is applied by means of a hand pump. A spring-stretched steel tape surrounds the cylinder, and a mark on this tape must return to the same point on a fixed scale after test as that from which it started at beginning of test. F. R.

1037. *Work of the Testing Department of Watertown Arsenal.* **J. E. Howard.** (Amer. Inst. Mining Engineers, Bull. 20. pp. 151–156, March; Discussion, 21. pp. 427–459, May, 1908.)—In the *discussion*, suggestions are given for directions which research on the metallurgy of steel should take. The particular lines include ingot structure in relation to homogeneity of rolled steel, especially rails and plates. In reply, the **Author** gives results obtained to date. These include an example of crescent fracture such as occurs in the base of a rail, and also white streaks (ghosts ?) in rails, in which fractures are shown to commence in some instances. Flaws are also shown to originate in manganese sulphide and silicate flaws in certain cases, and the skin hardening due to heating under passing wheels is illustrated. Cracks easily form in this hardened skin, particularly if manganese silicate be present. F. R.

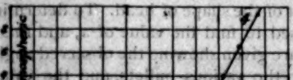
1038. *Laminated Springs for Wagons.* (Engineering, 85. pp. 554–555, April 24, 1908.)—Discusses the standard Clearing House specifications for springs on private owners' wagons in the new edition of "Specifications and Drawings" for such. The actual severity of the specified test for the material diminishes with the thickness. It is also pointed out that as the test for finished springs consists of flattening them to within a certain distance of the straight span, this gives different test stresses in the different standard springs, which are of the same design except as regards camber. It is shown that the buffer spring of greatest capacity for the specified stress, weight, span and working deflection should be made of ¾-in. plates. F. R.

1039. *Rusting of Steel in Concrete.* **J. M. Braxton.** (Eng. News, 59. p. 525, May 14, 1908.)—⅝-in. twisted steel rods were embedded in 12 × 12 × 6 in. blocks of concrete (1 : 3 : 5, the aggregate being broken brick, and the sand either coral or silica). After 24 hours' setting, half the blocks were immersed in the sea, and the rest were stored in the open air without roof protection. Upon breaking the blocks open 55 weeks later, the steel was perfect in all blocks kept in the sea, but was more or less rusted (in some cases negligibly) in all blocks kept in the air. With smaller broken brick (up to 1 in.) and silica sand, the blocks kept in the air almost perfectly protected the rods. F. R.

1040. *Trajectories of Projectiles with various shapes of Head.* **A. Mallock.** (Roy Soc., Proc. Ser. A. 80. pp. 519–529, June 10, 1908.)—Using the expressions formerly arrived at [see Abstracts Nos. 1285 and 1611 (1907)], the necessary elevation (α) for a projectile to remain in the air for a time t is given by $\alpha = gt^2v/2R - c(1 - \epsilon^{-at})$. Writing x for at and z for $(1 - \epsilon^{-at})$ we have $\alpha = x^2(1 - cz)/2a(v'x + u_0z)$. Of the three constants—v', c, and a—involved, v' and c are purely experimental, and a [$= f/(v - v')$, where f is the retardation at velocities from 1,000 to 8,000 ft. per sec.] consists of an experimental factor and another depending on the size and weight of projectile. 0·808-in. rifle projectiles were fired with a muzzle velocity of 2,480 ft. per sec., and their trajectories determined up to a range of 1,000 yards. The heads were flat, hemispherical, or ogival, with radius of ogive 2, 4, 6 or 12 diams. of projectile. Except with flat heads, values could be found for v', c, and a which would make the formula represent the results within the errors of observation, and it was found that v' and c were independent of the shape of head. To determine a the form $x = u_0z/[\sqrt{(g'R/2a)} - v']$ is used to find the value of x, and this is substituted in $\alpha = (v'x + u_0z)/R$. Curves are given showing the observed angles of elevation required at 1,000 yards for the various bullets, and the values which must be assigned to a for a given muzzle velocity and elevation at 1,000 yards' range. The agreement between the calculated and observed elevations for various ranges is fairly close. With another bullet at 2,880 ft. per sec. the result was in close agreement, but with bullets having an ogival head of large radius of ogive, but a slightly flattened nose, the observed curve is considerably different from the calculated. Diagrams show the angles of elevation and ranges for 6-in. and 12.-in guns, with muzzle velocity of 2,850 ft. per sec., and radius of ogive 2 and 12 calibres. The gain with the 12-calibre head is considerable in the case of the 6-in. gun, but much slighter at ranges up to 10,000 yards with the 12-in. The reasons of the departure of the flat-headed projectiles from the formulæ are (1) that the velocity rapidly falls below 1,000 ft. per sec., the lower limit of the formulæ—*e.g.*, with 2,480 ft. per sec. muzzle velocity, the velocity at 500 yards was less than 400 ft. per sec.; (2) their great lateral drift, which exceeded 80 in. at 500 yards, and was in the direction which the projectile would take if it rolled, in the sense of its rotation, upon the air lying above itself, *i.e.*, in the opposite direction to the drift of an ordinary pointed projectile. This confirms the observation of Owen (1862) which has been regarded as doubtful. Little is to be gained by increasing the radius of ogive beyond 12 diams. It is thought that angles of elevation of 25′ to 80′ may be possible with small arms, if the tail of the bullet be pointed to an angle less than that of the cone of vacuum behind a flat-base projectile, and if the bullets can be provided with fins which will enable them to hold a true course. F. R.

1041. *Attempt at a Physical Interpretation of the Significance of the Coefficient of Proportionality in Newton's Gravitational Formula.* **N. Morozov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40, 2, pp. 28–85, 1908.)—Every physical equation should be isothesic, and if the two sides are not apparently of the same dimensions they are connected by a coefficient, representing, in general, a combination of unforeseen factors. An attempt to express this coefficient as a function of its variables—for which the author prefers mass, length, and velocity—may lead to the discovery of the true sense of the physical phenomenon and to an indication, possibly imperfect, of its causes. The author regards the force of gravitation as composed of two forces, F_1 and F_2, belonging respectively to the two fields of force produced by the two masses, and from this point of view he has been enabled to discover the factor in Newton's formula corresponding with the vibratory movement. This movement is attributed to the molecules of the attracting bodies and is participated in by the surrounding medium, the force of gravitation being conceived as the hydrostatic pressure pushing one body towards the other. According to this theory, the force of gravitation should vary with the temperature of the attracting bodies. T. H. P.

1042. *Flow of Compressed Air through Capillaries.* **W. Ruckes.** (Ann. d. Physik, 25. 5. pp. 983–1021, April 28, 1908.)—Osborne Reynolds' equation $(\rho D U_m)/\mu = 1{,}900$ to $2{,}000$ for water, gives the critical velocity U_m at which a liquid of density ρ and viscosity-coefficient μ flows through a long, narrow tube of diam. D; with smaller velocities the particles move parallel to the axis of the tube, and with greater velocities vortex motion takes place. The question taken up by the author is whether a critical velocity exists for gases, and if so, how it is affected by the dimensions of the tube. Long, straight capillary tubes of glass and metal were employed, and the air could be passed through these at pressures varying between 200 atmos. and a few mm. of water. The three curves given indicate the critical velocities for a glass tube of 0·128 mm. diam., the lengths of the tubes for curves 4, 5, and 6 being 1,055, 295 and 163 mm. respectively; the ordinates give excess pressure in atmos. and the abscissæ the outflow in cm.³ per 30 sec. From many such experiments the author draws conclusions as follows: In the flow of air through narrow tubes, Reynolds' critical value holds for the beginning of turbulent flow. The deviations from this law are attributed to too short a tube or to the gradual widening of the inlet of the tube. Metallic capillaries give considerably smaller values for the critical velocity; the cause of this has not been investigated. Temperature measurements with thermo-elements gave the greatest fall of temperature near the outlet where, therefore, the greatest resistance is situated. G. E. A.



1043. *The Problem of a Spherical Gaseous Nebula.* **Kelvin.** (Phil. Mag. 15. pp. 687–711, June, and 16. pp. 1–23, July, 1908. Communicated in part to the Roy. Soc., Edinburgh, Jan. 21, 1907, and completed with the aid of the author's notes by G. Green. Appendix by **G. Green.** Roy. Soc. Edinburgh, Proc. 28. pp. 259–302, 1908.)—A globe of fluid, having any arbitrary distribution of temperature, subject to the condition of its being uniform throughout all spherical shells concentric with the globe, kept together by the gravitation of its parts and cooling by radiation, would be unstable until it attains approximate convective equilibrium [see Abstract No. 594 (1907)]. Convective equilibrium is the state in which any mass of the gas enclosed in a non-conducting envelope, raised in height, and allowed to expand as it rises until it attains the density due to the height, would at the same time so cool by expansion as to attain the temperature due to the height. If p, ρ, t denote the pressure, temperature, and density respectively, and if k denote the ratio of the specific heats, the relations between p, ρ, and t in convective equilibrium are given by the equations, called by Rankine the equations of adiabatic expansion—

$$\frac{p}{p'} = \left(\frac{\rho}{\rho'}\right)^{k} = \left(\frac{t}{t'}\right)^{\frac{k}{k-1}}.$$

It is assumed that the gaseous laws are approximately fulfilled, that is, that $p = \mathrm{S}t\rho$, where S is specific volume, and $p = \mathrm{A}\rho^{k}$, A denoting what the pressure would be at unit density, if the fluid could be gaseous at that density. But the gaseous laws cease to hold when the density exceeds a certain limit not less than one-sixth of that of water. This is because the known gases all display at such densities much greater resistance to compression than is consistent with Boyle's law. We might perhaps say that they can hold only when the third or Virial term in Clausius' equation $\frac{3}{2}p\omega = \Sigma\frac{1}{2}mv^2 + \frac{1}{2}\Sigma\Sigma\mathrm{R}r$, is very small compared with $\Sigma\frac{1}{2}mv^2$, but in very great densities this is not the case. If the mass of gas be very great, the mutual gravitation of its parts will produce a density at the centre too great for the substance to exist as gas. There will be a liquid or solid centre, and outside of that there may be gas in convective equilibrium. Kelvin considers the solar atmosphere. In it the force of gravity is approximately 28 times that of middle latitudes on the earth's surface. If it were in convective equilibrium, the temperature would increase at the rate of 280° C. per km. downwards, starting from absolute zero at the boundary. At a depth below 100 km. the temperature would be 28,000° C., and the density 0·816 of that of water. This, he says, is much too great for any known substance to exist as gas, even at that temperature—from which he concludes that the sun is probably not wholly gaseous. The rate of increase of temperature with depth is given by $dt/dz = (k-1)/k(g/s)$, where g is the force of gravity at depth z. A new constant, $\kappa = 1/(k-1)$ is now substituted for k. And the last equation is mathematically transformed into $d^2t/dx^2 = -t^{\kappa}/x^4$ . . . equation (24). If $t = \mathrm{F}(x)$ be any particular solution of this equation, Kelvin and Green give as the general solution with one disposable constant $t = \mathrm{CF}\left(x\,.\,\mathrm{C}^{\frac{1}{\kappa-1}}\right)$. The possible solutions may be divided into two classes: class A, in which the density increases continuously from the boundary to a finite maximum at the centre; class B in which, with increasing depth, we arrive at a point where the density is maximum or infinite, or in which it increases continuously to an infinite value at the centre with units chosen to make $\mathrm{F}(\infty) = 1$ (that is, F at centre where $x = 1/r = \infty$); the function F of class A is called Homer Lane's function. The equation (24) has been solved in finite terms for two values of κ—namely, if $\kappa = 1$ by Ritter, giving $t = x \sin(1/x)$; if $\kappa = 5$ by Schuster, giving $t = x\sqrt{3}/\sqrt{3x^2+1}$. Ritter's solution leads to results agreeing with Laplace's law of density for the earth's interior. It is shown in 43 and 44 that for all values of κ greater than 3, that is, of k less than 4/3, the gravitational attraction is *too small* to admit of convective equilibrium as a stable condition. But even in these cases there remains a dynamical problem of true fluid equilibrium continuous through the whole range of κ from 0 to ∞, or from -1 to $-\infty$, sufficient to give stability to a large globe of the fluid, balancing the effect of gravitation. If $k > 4/3$ gravity is too small, if less too great. Kelvin considers the case $\kappa = \infty$ or $k = 1$. This leads to $p/p' = \rho/\rho'$, or Boyle's law. He finds that in this case equation (24) gives $d^2 \log /\rho/dx^2 = -\rho/x^4$ . . . equation (32), where $x =$ constant/ρ. This is the equation of equilibrium of a Boylean gas under the influence of its own gravitation only. In (33) this problem is worked out. If $\rho = F(x)$ be a particular solution of equation 32, the general solution, with one disposable constant C, is $\rho = CF(x/\sqrt{C})$. When this particular solution belongs to class A (*ante*), he writes $\psi(x)$ for $F(x)$. And in the Appendix the values of $\psi(x)$ and of $\psi'(x)/\psi(x)$ are calculated by Green for a series of values of x from $x = 0{\cdot}1$ to $x = \infty$. By means of the values thus given, the density at any point distant r from the centre of an ideal Boylean gas, and the mass of gas within any sphere of radius r, when the gas is in equilibrium under its own gravitation only, can be calculated; and there may be more than one state of equilibrium with different central densities. Examples are given in 37 with the central density 1 or 1·21. Similar results can be obtained for a finite mass of any gas for which $\kappa > 3$, or $k < 4/3$, but if $\kappa < 3$, increase in the central density causes diminution in the radius R of the sphere containing the whole mass. It appears from the tables given in (37) that for the Boylean gas ($\kappa = \infty$), R increases as the central density increases. These results appear more clearly by comparing the work, W, done by gravity in bringing the whole mass of gas from an infinite distance to its actual position in equilibrium in a sphere of radius R, with I, the whole energy within the sphere of radius R. It is found that $I/W = \kappa/3$. According to this, gases may be divided into two classes: P, gases for which a globe of gas in equilibrium with uniform temperature for all concentric surfaces has I less than W, *i.e.*, $\kappa < 3$, and Q, gases for which $I > W$. And it is shown that for Q-gases the equilibrium is unstable. Because if $I > W$ the globe tends to expand, and since I and W then diminish by equal quantities, its expansion increases the ratio I/W. These results were given by J. Perry (Nature, July 13, 1899). In 52 is given the solution of the general problem to determine for any spherical gaseous nebula of given mass, initially in convective equilibrium, what its radius was, what its central temperature and density were, and what its temperature and density were at any distance r from the centre, at that point of time when a given quantity of heat had been radiated into space. The result cannot be better given than by quoting (53). "The central temperature of a globe of gas P increases through gradual loss of energy by radiation. Also the internal energy of a globe of gas P continuing in approximate equilibrium while heat is being radiated into space, and the work (W) done by the mutual gravitation of its parts go on increasing, until the gas in the central regions becomes too dense to obey Boyle's law. At the same time the radius of the globe diminishes. In other words, the repulsion due to the internal energy is owing to loss of energy by radiation just insufficient to exactly balance the attractive force. The globe is therefore compelled to contract, and as the heat due to this contraction is not radiated away so fast as it is produced, the shrinkage of the globe is accompanied by increase of its internal energy." In 57 the theory is applied to spherical masses of argon and nitrogen. The Appendix contains a mathematical treatment of equation 24 and numerical calculations which are compared with those of Homer Lane and T. J. J. See. S. H. B.

1044. *Thermodynamical Formulæ and Tables for Meteorologists.* **P. Schreiber.** (Abstract by **A. Schreiber** in Meteorolog. Zeitschr. 25. pp. 187–190, April, 1908.)—The author has published a quarto volume of 86 pages and 9 plates, a continuation of a previous work, containing many novel features, which the critic submits to a very favourable review. The entropy calculations are mentioned, for instance. Many constants had been taken from Zeuner; the author noticed, however, that discrepancies would arise, for extreme temperatures, from the coefficient 0·791 in the formula for the internal heat: $\rho = 575 - 0{\cdot}791t$, instead of which he proposes 0·68, nearly agreeing with Mollier's value 0·647. H. B.

1045. *Intensity of Solar Radiation in Vienna.* **F. M. Exner.** (Meteorolog. Zeitschr. 25. pp. 125–126, March, 1908.)—The observations conducted at the Zentralanstalt für Meteorologie from March, 1904, to Sept., 1906, with Ångström compensation pyrheliometers have been analysed by R. Schneider. Observations are taken at intervals of about 2 hours by ten observers; the situation is not favourable for the determination of the solar constant. The cm.^{2} of soil in Vienna receives in the course of a year 52,835 gm.-cals.; not quite double that figure would be received if there were no clouds, which reduce the radiation in Dec. to 28 per cent. of its real value, and in Aug. to 64 per cent. A July day receives nearly 20 times as much heat as a Dec. day; 4·7 mm. of water could be evaporated on an average on the former day, and 0·3 mm. on the latter. The figures are not directly comparable with those of L. Gorczynski for Warsaw. The following averages for the total solar radiation received in the course of a year in kg.-cals. per cm.^{2} of soil are due to Gorczynski (and also to Schneider):—

	Montpellier.	Vienna.	Kiew.	Warsaw.	Stockholm.	Treurenberg.
Latitude ...	46·3°	48·3°	50·4°	52·2°	59·3°	79·9°
Radiation...	71·8	52·3	60·7	50·9	55·3	16·8

H. B.

1046. *Nocturnal Radiation.* **A. Lo Surdo.** (N. Cimento, 15. pp. 258–272, April, 1908. Paper read before the Soc. Ital. di Fisica at Parma.)—Previous work on this subject is first briefly summarised, the value of the intensity of radiation found by different observers varying from 0·128 to 0·268. Adopting a slight modification of the thermoelectric method of Ångström, the author has determined the intensity of radiation on a cloudless night at Naples, starting before sunset, and concluding after sunrise the following morning. A max. intensity of 0·196 was observed about half an hour before sunrise, the value being about 0·9 of this within 3 hours of sunset the previous evening. The minimum obtained at this latter hour (at which an approximate idea of the intensity for the night may be formed), with a sky completely clouded over, was 0·08. The intensity of the radiation increases rapidly immediately after sunset, and suddenly falls at daybreak, but shows little variation during the night. There appear to be two maxima, one a few hours after sunset, the other shortly before sunrise. W. H. Sr.

1047. *Relation between Surface Pressures and Wind Speeds at* 1,000 *Metres Altitude.* **E. Gold.** (Roy Soc., Proc. Ser. A. 80. pp. 436–448, May 25, 1908.)—For the steady horizontal motion of air along a path whose radius of curvature is r, the author gives the equation—

$$\frac{(\omega r \sin\lambda \pm v)^2}{r} = \frac{1}{\rho}\cdot\frac{\partial p}{\partial r} + \frac{(\omega r \sin\lambda)^2}{r},$$

expressing the fact that the part of the centrifugal force arising from the motion of the wind is balanced by the effective gradient of pressure. In this equation p is atmospheric pressure, ρ density, v velocity of moving air, λ is latitude, and ω is the angular velocity of the earth about its axis. If $\partial p/\partial r$ be negative, it is clear that v and $\omega r \sin \lambda$ must have opposite signs; or, for motion in a path concave towards the higher pressure, the air must rotate in a clockwise direction, the well-known result for anticyclonic motion. Further, the maximum numerical value of $\frac{1}{\rho}\frac{\partial p}{\partial r}$ is $\frac{(\omega r \sin \lambda)^2}{r}$, and the corresponding maximum value for v is $\omega r \sin \lambda$. Therefore, in anticyclonic regions there are limiting values which the gradient and the velocity cannot exceed. This limiting value of v for latitude 50° and $r = 100$ miles is approximately 20 miles per hour. At the surface of the earth, owing to friction and eddies, the mean direction of the motion of the air is nearly always inclined to the isobars; but over the sea the inclination is very much less, and it seemed probable that in the upper regions of the atmosphere, if the motion were steady, the air would in general move tangentially to the isobars, and its velocity would agree with that calculated from the equation given above. The question, however, arises as to whether the pressure is likely to continue steady long enough for a condition in which the equation is applicable to supervene. This matter is then discussed mathematically and the theoretical conclusions compared with data from observations at Berlin and Lindenberg in 1905. The upper wind at these places was found to coincide very nearly with the isobars at the surface, and the wind velocities observed agreed well with those calculated from the pressure distribution. E. H. B.

1048. *Earthquake Waves.* **E. Wiechert** and **K. Zoeppritz.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 415–549, 1907.)—The first part is a theoretical investigation of the propagation and mode of vibration of earthquake waves, which cannot well be abstracted. In the second part Zoeppritz deals with "Laufzeit" curves (abscissæ, distances measured along the earth's surface, ordinates the "Laufzeit" or duration of propagation). It is shown that a correction for the depth of the hearth can be omitted at present, until a close network of observing stations exists. The three earthquakes considered are the Indian earthquake of April 4, 1906, the Calabrian of Sept. 8, 1905, and the Californian one of April 18, 1906. The curves obtained are shown together with those of Koevesligethy, Milne, Benndorf, and Oldham. The dependence of the longitudinal and transversal velocity of propagation upon the depth, calculated after Wiechert's method, shows that the curves indicate a marked increase to a depth of 1,500 km., and then remain constant (at 12·9 and 16·75 km./sec. respectively). Later results are referred to by Wiechert in a more recent and more general paper (Phys. Zeitschr. 9. pp. 36–47, 1907). These point to the fact that beyond this depth a small decrease of velocity occurs as the centre of the earth is approached (from 13 to 10 km., perhaps, for longitudinal waves). [Compare Abstracts Nos. 883, 1305 (1907).] L. H. W.

1049. *The Etna Eruption of April 29–30, 1908.* **A. Lacroix.** (Comptes Rendus, 146. pp. 1071–1076, May 25, 1908.)—After the eruptions of 1883, 1886, and 1892, Etna had not been seriously disturbed, although the central crater had been threatening since 1906. From the observations taken by Riccò and Platania and by the author, it would appear that the eruption was very brief, like that of 1883. The lava issued from a cleft above the Val del Bove, about

1 km. in length, at an altitude of 2,500 m., a little higher up than the eruption of 1819. After April 30, the activity was confined to the emission of vapours; the author could hence begin his study immediately after the eruption. He describes his observations in detail. The earthquake shocks recommenced after the cessation of the eruption and had not stopped a fortnight later, when the author's account was written. H. B.

1050. *Origin of Atmospheric Ozone and Causes of Variation in the Proportion of Carbonic Acid.* **H. Henriet** and **M. Bonyssy.** (Comptes Rendus, 146. pp. 977–978, May 11, 1908.)—A summary of an exhaustive investigation, full details of which are promised shortly. It is concluded that (1) ozone is formed from oxygen in the higher regions of the atmosphere under the influence of solar ultra-violet radiations; (2) ozone is brought down to the surface of the earth by wind and rain; (3) in a still and clear atmosphere, solar radiations also convert oxygen nearer the earth into ozone; (4) the proportion of carbonic acid is reduced below normal by dilution with air from higher regions, so that the amount of carbonic acid varies inversely with that of ozone present; and (5) increase of carbonic acid above normal is always due to local conditions, *e.g.*, respiration of man or animals, combustion of organic matter, discharge from the soil owing to heat, or fog. W. H. St.

1051. *Rotation of Sun from Hydrogen Lines.* **W. S. Adams.** (Astrophys. Journ. 27. pp. 213–218, April, 1908. Contribution from the Mt. Wilson Solar Observatory, No. 24.)—In the investigation of relative displacements of spectrum lines at the sun's limb, first found by Halm, and afterwards confirmed by Hale and Adams, a number of plates were obtained showing the hydrogen lines. Since hydrogen extends to a great height in the solar atmosphere, it seems probable that the vapour which contributes to the formation of the hydrogen lines in the solar spectrum lies at a generally higher level than that giving rise to the greater number of the Fraunhofer lines. If, then, the observed displacements at the sun's limb are due to pressure, the hydrogen lines might be expected to show smaller displacements than the other lines. A series of measures on the red H_a line have accordingly been made, and the displacements found are exceedingly small, in general less than 0·001 Ångström unit. The same measures give values for determining the rotation, each point at the limb being compared with an area near the centre. From the examination of these results it appears that the rotational velocity of the hydrogen gas is decidedly higher than that of the general reversing layer, amounting at the equator to 1° in the angular motion. Thus the effective level of the vapours (the integrated action of which gives rise to the hydrogen lines at the sun's limb), lies very high in the sun's atmosphere, and at this higher level the angular velocity is considerably greater than in the region close to the photosphere. A second important conclusion is that at the level of the hydrogen gas at which the spectrum lines are formed the law of the sun's equatorial acceleration has ceased to hold. The values of the angular rotation for all latitudes, with the possible exception of 73·5°, are practically constant. [See also next Abstract.] C. P. B.

1052. *Rotation of Sun from Motions of Hydrogen Flocculi.* **G. E. Hale.** (Astrophys. Journ. 27. pp. 219–229, April, 1908. Contribution from the Mt. Wilson Solar Observatory, No. 25.)—The material for this investigation consists of a large collection of spectroheliograms taken during the period

Oct., 1908, to Feb., 1908, with the 5-ft. spectroheliograph at the Mount Wilson Solar Observatory, chiefly taken with the H_δ line of hydrogen. The rapid changes in the forms of these hydrogen flocculi make the identification of objects for measurement the most difficult part of the investigation, and they are also subject to proper motions much larger than those observed in the case of the calcium flocculi. The plates have been measured by means of the heliomicrometer, which gives the solar latitude and longitude of the centre of each flocculus. One of the first important results is that the hydrogen flocculi show no systematic variation of the mean angular rotation with the latitude, from which it would appear that this stratum lies at a high level. Independent evidence has been also obtained from the parallactic displacement of hydrogen and calcium flocculi near the limb, indicating that the hydrogen masses are at the higher level. Another important feature is that specially dark hydrogen flocculi appear to be associated with dark calcium flocculi, and may thus be prominences photographed in projection on the solar disc. C. P. B.

1053. *Structure of the Corona.* **A. Hansky.** (Mitteilung d. Nikolai-Hauptsternwarte zu Pulkowa, vol. 2. No. 19. Nature, 77. p. 590, April 23, 1908. Abstract.)—Discussion of the results of a study of the corona photographs taken during the total solar eclipse at Alcocèbre, Spain, on Aug. 30, 1905. The object was to determine the velocity of propagation of the coronal matter. The corona was of the *maximum type*, showing activity all round the disc, and the streamers are divided into eight groups. It appears probable that the forms and directions of these streamers depend to some extent on the prominences near which they are found. The centres of emission do not coincide with spots which are found near them. The movement of coronal matter above prominences is extremely slow—about 30 km. per sec.—while the velocity of the prominence matter often approaches 200 km. per sec. C. P. B.

1054. *Heliocentric Positions of Coronal Streamers.* **J. A. Miller.** (Astrophys. Journ. 27. pp. 286–295, May, 1908.)—A theory is developed for computing the paths of coronal streamers on the assumption that they are due to particles of matter expelled from the solar surface and following definite orbits. The theory is tested from measurement of photographs obtained at Almazan, Spain, during the total solar eclipse of Aug. 30, 1905, with a lens of 9 in. aperture and 60 ft. focal length. The measures furnish evidence of a very strong repulsive force in addition to any force of ejection. C. P. B.

1055. *Solar Prominences in 1907 at Kodaikanal, India.* **J. Evershed.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 515–516, May, 1908.)—The year 1907 was one of considerable activity as regards prominences. At Kodaikanal 78 prominences of 100″ or upwards were recorded during 305 days of observation. Photographic records show seven eruptive prominences, the greatest elevation of 6¼ minutes of arc being measured on March 14 in solar latitude +52. Metallic prominences were frequent, 111 being recorded during the year. The high latitude prominences showed the spectra of Na, Mg, and Fe; those in spot latitudes gave in addition lines of Ba and Ca. C. P. B.

1056. *Total Eclipse of the Sun, Jan. 3, 1908.* **W. J. S. Lockyer.** (Nature, 77. pp. 8–10, May 7, 1908.)—Description of the observations made by F. K. M'Clean's party at Flint Island. Rain came on suddenly just before totality, and lasted until 1 sec. before beginning of the eclipse. Then photographs were started through the thin clouds, and continued for the rest of the eclipse. Excellent pictures of the corona were secured, showing numerous streamers and approximately of the maximum type, with considerable activity all round the moon's limb. C. P. B.

1057. *Photometric Measurements of Saturn.* **J. M. Baldwin.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 368–378, March, 1908.)—During the opposition of Saturn in the autumn of 1907 a series of photometric measurements were made with the Zöllner photometer of the Astrophysical Observatory, Potsdam, having an aperture of 21·5 mm. and focal length 187 mm., the image of the planet therefore differing but little from that of a star. There was no suitable comparison star in the immediate neighbourhood of the planet, and α Aquilæ was used for this purpose throughout the observations. The author concludes that the spheroid of Saturn does show a change of brightness with phase, and the variation in magnitude may be represented by the formula already obtained by Müller. C. P. B.

1058. *Illumination of Dark Side of Saturn's Rings.* **H. N. Russell.** (Astrophys. Journ. 27. pp. 230–233, April, 1908.)—The discovery by Barnard that, when the shaded side of Saturn's rings is turned towards us, the line of light which we see is the faintly illuminated surface of the rings, and not their sunlit edge, suggests that their visibility is due to light reflected from the ball of the planet [see Abstract No. 571 (1908)]. Of the two pairs of condensations seen upon the line of the rings, the outer ones fall upon the brightest part of the inner ring, which, according to Barnard, is much the brightest portion of the entire ball and ring system. The apparent area of one of the condensations is about $\frac{1}{150}$ of that of the planet, and if the two were of the same albedo, and both illuminated by direct sunlight, the light of the condensations should be 6 magnitudes fainter than that of Saturn. Their illumination by reflected light is, however, about 160 times fainter than by direct sunlight, so that in this case they should appear about 11½ magnitudes fainter than the planet. Barnard found them distinctly brighter than Mimas, Enceladus, or Tethys, and this supports the above calculated brightness. The inner condensations appear to be due to the illumination of the partially transparent crape ring by sunlight coming through it from the outer side, through the gaps between the particles; the outer condensations are due to the reflected light from the planet. **E. E. Barnard.** (Ibid. pp. 234–235.)—Barnard points out that the principal source of illumination of the dark side of the rings was sunlight percolating through the intervals between the particles. In July (1907) the minor axis of the ring ellipse was nearly three times as great as after the second disappearance in Oct. Reflected sunlight from Saturn could not illuminate all of the surface of the ring thus visible. During observations made at the Yerkes Observatory on July 2, Nov. 3 and 5, 1907, the inner condensations appeared double. The outer condensations were almost round in the first part of Nov., but in Dec. they were decidedly flattened. C. P. B.

1059. *Correlation of Stellar Characters.* **W. Gibson** and **K. Pearson.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 415–448, March, 1908.)—An attempt to determine the numerical relationships between various star characters, such as magnitude, colour, spectral class, proper motion, parallax, position, &c. Other workers have shown that the distribution of star characters is probably not one of mere random association [Abstract No. 214 (1908)]. The chief results may be classified as follows: *Colour and Magnitude.*—The distribution of luminosity among the coloured stars gives a curve remarkably similar to that of luminosity in the solar spectrum, if we shift the solar curve towards the violet end. *Colour and Spectral Class.*—The colour of a star depends to some extent on its magnitude, as above, but in a far more marked manner on its spectral class. *Magnitude and Spectral Class.*—Using the most recent temperature classification of Lockyer, it is found that magnitude is very far from being independent of spectral class, but the reason why certain spectral classes have differentiated magnitudes is not yet evident. Between spectral class and proper motion and parallax there are fairly considerable relations, and it would thus appear that the chemical constitution of a star is not only associated with colour and brilliancy, but also with its position in space, its motion in space, and its size. From an investigation of the parallax and proper motion of 72 Yale stars it is determined that the mean parallax of a system of stars of given proper motion is one-fifteenth of that proper motion, and it is noteworthy that this result is identical with that formulated by Newcomb (Astronom. Journ. vol. 22. p. 169, 1902). The authors conclude that the associations between parallax, proper motion, and magnitude are considerably less than would be anticipated on the assumption of any approach to a uniform distribution of stars with a system of random velocities through space. The existence of correlations between colour and spectral class, not only with magnitude, but with parallax and proper motion, suggests, if it does not demonstrate, that chemical constitution and luminosity are dependent in some manner, not only on spatial distribution, but on velocity in space. C. P. B.

1060. *Photographic Determination of Star-colours and their Relation to Spectral Type.* **J. A. Parkhurst** and **F. C. Jordan.** (Astrophys. Journ. 27. pp. 169-182, April, 1908.)—The method is based on a suggestion made by Schwarzschild that the difference between the visual and photographic magnitudes of a star would give an accurate measure of its colour, but with the addition that here the "visual" magnitudes are also obtained by photographic means simultaneously with the photographic magnitudes. The authors have aimed, first, at supplying a means of accurate measurement of star-colours; second, at enabling visual and photographic magnitudes to be co-ordinated; and third, at contributing to the study of stellar evolution, the relation of colour to state of development being a close one. Pairs of ordinary and isochromatic plates were taken regularly from 1904 to 1906 with the 24-in. reflector of the Yerkes Observatory for the purposes in view. In 1906 Wallace prepared a "visual luminosity" filter which, when used with properly sensitised plates, is said to give "visual" magnitudes of coloured stars without any correction [see Abstract No. 48 (1907)]. Plates of the field round the red star U Cygni, taken, one on an ordinary Seed plate, the other on a trichromatic plate with filter, are shown in illustration of this statement. Curves of sensitiveness are drawn for the two plates which explain the results. The magnitudes are obtained from the plates by measuring the disc diameters under the microscope, and reducing by means of the formula: mag. $= a - b\sqrt{D}$, where D is the disc-diameter and a and b are constants, a depending on the exposure, b on the emulsion, &c. The trichromatic plate with filter required 9 times the exposure of the Seed, but in June, 1907, Wallace brought out his new Pan-iso plate, bathed with pinacyanol, pinaverdol, and homocol, requiring 5 times the exposure of the

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Seed. These two discoveries considerably facilitated the investigation. Owing to the fact that the maximum of visual luminosity shifts towards the blue with decreasing illumination (Purkinje's phenomenon), a photograph can only agree with some particular visual scale for coloured stars at a single magnitude with some particular aperture. From a comparison between the "visual" magnitudes, derived from the Pan-iso plates and those taken from the Potsdam Photometric *Durchmusterung*, the authors deduce, first, that the two systems agree at magnitude 6·0; second, that the plates give correct visual magnitudes of coloured stars, which has usually been considered impossible. For the inquiry into the relation between colour-intensity and spectral type, spectrograms were taken with an objective prism. The Draper catalogue classification is adopted, forms intermediate between the classes being indicated by tenths of the interval, according to the relative strength of certain lines. Data for 49 stars are given in detail. Variable stars are excluded, the measures showing that the colour intensities of both short- and long-period variables increase with decreasing light. The well-known contrasted colours of some wide double stars are at present being examined. The provisional results of the authors' investigation are summarised as follows: (1) The photographic method furnishes a practically simultaneous determination of visual and photographic magnitudes free from most of the uncertainties of visual methods. (2) The system can be definitely stated by its spectral intensity curves, and exactly reproduced by any observer. (3) The colour results are stated in magnitude differences. (4) As definite colour intensities correspond in general to definite spectral types, this method furnishes a means of determining the spectrum of stars too faint for the ordinary spectroscope. One hour's exposure with an 18-in. reflector will give measurable colours of stars to the 14th magnitude. A. E.

1061. *Proper Motion of Small Stars.* **S. W. Burnham.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 517–522, May, 1908.)—Small stars having any sensible proper motion which can be detected by meridian or micrometric observations, so far placed on record, are much rarer than parallax stars taken from all magnitudes, bright or otherwise. It thus happens that when the prominent stars have been connected by measures with faint stars in the field by the Struves and other old observers, we have a value of the proper motions of the large stars which is a safe and certain correction to that given by meridian positions. A series of measures of one of these faint stars in Lyra is given as an example. C. P. B.

1062. *A. Roberts' Method of Determining the Absolute Dimensions of an Algol Variable Star.* **J. Stein.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 490–492, April, 1908.)—Roberts starts from the hypothesis that the light-changes of the Algol variables U Pegasi and RR Centauri are fairly well explained by two eclipsing stars moving in a circular orbit, and tries to reduce the residuals (observed results *minus* computed) by applying some corrections to the theoretical light-curve [see Ibid. 66. p. 123]. He supposes that the orbit is passing through the line of sight, and, neglecting the second and higher powers of the eccentricity, proceeds to form a certain equation of condition in which the three first terms represent corrections depending on eccentricity and variation of epoch, and the fourth term the correction due to the fact that light takes an appreciable time, 2*l* minutes, to traverse the orbit. Then, resolving the equations of condition by the method of least squares, Roberts finds *l*, and consequently the absolute dimensions of the orbit. The present author points out that this method is open to criticism, and that the corrections due to eccentricity, variation of epoch, and aberration are not adequately expressed by the terms of Roberts' fundamental equation. To show this he takes the most simple case, where the two components are spherical, and the nearly circular orbit passes through the line of sight. In this case the apparent brightness of the binary system depends only on the apparent distance ρ of the centres of the two spheres, as seen from our sun. Calculating the corrections under these circumstances, he finds that the light-equation fails to yield the expected information about the orbit, the result obtained indicating that it is theoretically impossible to determine the absolute dimensions of the orbit in the above manner. It would follow that Roberts' numerical results cannot have the interpretation given to them. A. E.

1063. *Light-curve of δ Cephei.* **J. Stebbins.** (Astrophys. Journ. 27. pp. 188–193, April, 1908.)—Between June, 1906, and Sept., 1907, a long series of photometric measures of δ Cephei were made with a polarising photometer attached to the 12-in. refractor at the University Observatory at Illinois, the comparisons being determined with the 6th magnitude companion star at 41″ distance. The range of magnitude is from 3·6 to 4·3 magnitude. As the variable is redder than the companion, it was anticipated that moonlight would affect the measures, and therefore the illumination of the field of view was recorded for each observation on an arbitrary scale of 0–5. The results are presented graphically, and show evidence of secondary fluctuations with maxima at 0·4 day and 4·6 days from minimum, the chief maximum being at 8·0 days from minimum. C. P. B.

1064. *Variability of Planetary Nebula, N.G.C. 7662.* **E. E. Barnard.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 465–481, April, 1908.)—This remarkable nebula, in Andromeda, looks like a small round disc of a bluish-green colour in an ordinary telescope. With the 40-in. Yerkes refractor it appears as a slightly elliptical disc with quite sharply defined outlines. Unsymmetrically placed on this is a roughly elliptical broken ring of greater brightness. The interior of the ring is dark, but not black, and in this, approximately central, is ordinarily a flat nucleus which sometimes appears of a yellowish colour. This nucleus was suspected to be variable soon after the author's first observations of the nebula in 1897, and continued work has proved that the variation amounts to at least 3 magnitudes. At its brightest it may be about the 12th magnitude; the period appears to be about 28 days. The paper includes details of all observations made with the 40-in. Yerkes refractor during the last ten years. Several photographs were obtained which confirmed the change of brightness in the nucleus. A drawing is given showing the details seen with the 40-in. telescope.

C. P. B.

REFERENCES.

1065. *Suspension of Powders in Liquids and Gases.* **J. Sahulka.** (Ann. d. Physik, 25. 5. pp. 885–893, April 28, 1908.)—This paper discusses the problem of the supporting of substances (in the form of powder) by liquids and gases. Experiments, in favour of the theory, on the fall of small spheres through liquids contained in tubes are described; and a possible explanation is given as to why it is easier to swim in deep water than in shallow water. A. W.

1066. *Magnetic Damping of Horizontal Pendulums.* **B. Galitzin.** (Acad. Sci. St. Pétersbourg, Bull. 8. pp. 673–686, May 1, 1908.)—Description of a system of damping the vibrations of the horizontal pendulum detector of earth disturbances, by attaching a copper plate to the boom and arranging it to swing between the poles of a powerful magnet. Examples of the degree of damping produced are given. C. P. B.

1067. *Horizontal Pendulum Constants.* **B. Galitzin.** (Acad. Sci. St. Pétersbourg, Bull. 9. pp. 743–758, May 15, 1908.)—An analytical discussion of the determination of the damping constants of the horizontal pendulum seismometer. C. P. B.

1068. *Sunset and Twilight Curves.* **D. M. Y. Sommerville.** (Roy. Soc. Edinburgh, Proc. 28. pp. 311–336, 1908.)—The author describes certain curves which approximate to the graphs of the times of sunset (or sunrise) and the end of twilight (or daybreak) all the year round for various latitudes, and also tabulates the yearly phenomena of light and darkness for different latitudes under various conditions. C. P. B.

1069. *Temperature of the Sun.* **D. A. Goldhammer.** (Ann. d. Physik, 25. 5. pp. 905–920, April 28, 1908.)—An analytical discussion of radiation observations at various stations, to determine the effective temperature of the sun. The result is given as T = 10,000° (absolute). C. P. B.

1070. *Reversals of Spectral Lines in Chromosphere.* **G. Meslin.** (Journ. de Physique, 7. pp. 454–463, June, 1908.)—The action of two or more layers of absorbent vapour lying above the reversing layer are considered, with the selective effect where one or more of these layers is thinned out or absent, as over a spot group or faculæ where reversals are very frequent. C. P. B.

1071. *Masses and Elements of Jupiter's Satellites.* **W. de Sitter.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 653–673, and pp. 710–729, April 24, 1908.)—A determination of the elements and masses of the satellites of Jupiter, and of the mass and the dynamical compression of the planet, based on the heliometric and photographic observations made at the Observatories at the Cape of Good Hope, Pulkowa, and Helsingfors during the years 1891–1904. C. P. B.

1072. *Radial Velocity of ι Ursæ Majoris.* **Baker** and **Schlesinger.** (Publications of the Allegheny Observatory, vol. i., No. 4, p. 23. Nature, 78. p. 111, June 4, 1908. Abstract.)—From spectrograms obtained during March and April, 1907, with the Mellon spectrograph. The resulting velocity was —7·1 km. per sec., agreeing very closely with the determination by Adams. C. P. B.

1073. *Spectroscopic Binary, i Orionis.* **J. S. Plaskett** and **W. E. Harper.** (Astrophys. Journ. 27. pp. 272–279, May, 1908.)—Measures for determination of the orbit were made on 107 plates taken between Dec. 11, 1906, and Jan. 25, 1908. The spectrum is of the helium type, and the chief lines of hydrogen, helium, and calcium were taken for reduction of the velocity. A diagram of the orbit with determined elements is given. C. P. B.

1074. *Determination of Orbits of Spectroscopic Binaries.* **W. F. King.** (Astrophys. Journ. 27. pp. 125–138, March, 1908.)—On the assumption that the orbit of the star is an ellipse described about a centre of force in one focus, the graph formed by taking the velocities in the line of sight as ordinates and the corresponding times as abscissæ will be a periodic curve, from which can be determined the elements of the orbit, and it is shown in the present paper how as much as possible of the work of testing the accuracy of the successive graphs and of preparing the ephemerides may be done graphically. C. P. B.

LIGHT.

1075. *Tower Telescope of Mount Wilson Solar Observatory.* **G. E. Hale.** (Astrophys. Journ. 27. pp. 204–212, April, 1908. Contribution from the Mt. Wilson Solar Observatory, No. 23.)—In 1907 the author outlined a scheme of installation of spectrographic equipment for eliminating atmospheric disturbances in solar work as much as possible [Abstract No. 621 (1907)]. The instrument is now in regular use, and the present paper gives a complete description, with scale drawings, photographs of the various parts, and of some of the first spectroscopic results. The coelostat is mounted about 65 ft. above the ground on a steel tower steadied by wire guys, and sends the light to a secondary mirror on the same platform. From this it is reflected to the objective lens, 12 in. (30·5 cm.) diam. and 60 ft. (18·29 m.) focal length. The image of the sun thus formed is about 5 ft. above the ground-level in a small building at the base of the tower. The spectrograph and spectroheliograph, each of 30-ft. focus, extend further downward in a concrete-lined shaft. The advantages of this system are: (1) Great thickness of mirrors eliminates astigmatism and changes of focal length; (2) the use of an objective instead of a mirror gives the shortest possible path between the coelostat and the focal plane, and decreases the changes of focal length experienced with a concave mirror; (3) the use of a vertical beam of light giving less probability of disturbance due to atmospheric convection currents. Photographs of spot spectra obtained with the new apparatus are much superior to the old series, and a reproduction is given showing comparison spectra of sun-spot and disc in the region of λ5100–5200. For the first time bright reversals are shown in many of the lines, as was described some time ago by Mitchell. With the spectroheliograph under construction two camera slits will be employed, enabling comparison of two monochromatic light images to be taken simultaneously, this being necessary for studying the forms and positions of flocculi of different elements. C. P. B.

1076. *Definition Tests of the Yerkes 40-inch Objective.* **P. Fox.** (Astrophys. Journ. 27. pp. 237–253, May, 1908.)—The investigation was undertaken to provide comparison data for the 40-in. objective on the same system that had been employed for many of the other refractors at the large observatories. A perforated diaphragm was employed for the zonal test, having 60 holes located at the corners of squares on 15 different zones, each hole being 2 cm. diam. Measurements of the extra-focal images bring out the characteristics of the objective very clearly, and it is at once apparent that the centre of the objective is of appreciably shorter focal length than the edge. Interesting photographs by the Foucault knife-edge test are given, showing a very great amount of structural detail on the lens surface. Additional investigations of the colour-curves with a special diaphragm resulted in the practical confirmation of the curve previously determined by Ellerman. C. P. B.

1077. *Monochromatic Illuminator.* **H. E. J. G. du Bois, G. J. Elias, and F. Löwe.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 729–734, April 24, 1908. Communication from the Bosscha Laboratory.)—Various forms of apparatus have been devised for securing pure illumination by monochromatic light [see Abstracts Nos. 1000 (1904), 1858 (1906), and 41 (1907)]. The apparatus here described is specially designed to give great brightness as well as purity. The auto-collimation type of optical train was chosen, giving double dispersion with a given number of prisms—in this case two whole prisms and two half-prisms. For ultra-violet work the glass optical train is replaced by one of quartz. Used as a spectrometer the resolving power is about 65,000; with the high-power eyepiece the yellow helium line is resolved into its components, distance about 0·085 $\mu\mu$.

C. P. B.

1078. *Empirical Law of Atmospheric Refraction.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 496–510, May, 1908.)—The recent investigations of the "isothermal layer" at a height of 10–12 km. above the earth's surface has led to revisions of the usual astronomical assumption for refraction computations, as the temperature gradient is evidently far from uniform. For simplicity the refraction constants were calculated on the assumption that we deal with one or two homogeneous spherical shells, and it was soon found that this satisfied the conditions almost as well as the more cumbrous rigid theory generally adopted. C. P. B.

1079. *Refractive Index and Dispersion of Light in Argon and Helium.* **W. Burton.** (Roy. Soc., Proc. Ser. A. 80. pp. 390–405, May 25, 1908.)—A determination of the absolute index of refraction for light of definite wave-lengths, and hence the dispersion of argon and helium. A Jamin refractometer was used, and the light reflected from the second plate was focussed upon the slit of a grating spectrometer. The spectrum was seen crossed by bands of maximum and minimum intensity, and at the same time a comparison spectrum was thrown in, namely, that from a vacuum tube containing H, He, and Hg. The tubes of the interferometer were of brass, 109·95 cm. long and 0·8 cm. internal diam. In the case of helium, in order to obtain the shift of a sufficient number of bands, the pressure-range was 1,800 mm. The following results were obtained :—

Argon $\mu_{D_1} = 1{\cdot}0002837$ Helium $\mu_{D_1} = 1{\cdot}00003500$

and $\mu = 1{\cdot}0002792 + \dfrac{1{\cdot}6 \times 10^{-14}}{\lambda^2}$. and $\mu = 1{\cdot}00003478 + \dfrac{7{\cdot}6 \times 10^{-16}}{\lambda^2}$.

E. C. C. B.

1080. *Refractive Indices of Gaseous Nitric Oxide and Sulphur Trioxide.* **C. Cuthbertson** and **E. P. Metcalfe.** (Roy. Soc., Proc. Ser. A. 80. pp. 406–410, May 25, 1908.)—The refractive index of NO is found as a mean of eight experiments to be $\mu_D = 1{\cdot}0002939$, which is distinctly higher than the additive value 1·0002837. This peculiarity is common to all nitrogen compounds which have yet been observed, but is more strikingly evidenced in the cases of SO_2 and SO_3. The value of $(\mu - 1)10^6$ for SO_2 is found to be 660·86 and for SO_3 about 737, while the respective additive values are 825 and 960. E. C. C. B.

1081. *Dispersion of Rock-salt and Sylvin in the Infra-red.* **F. Paschen.** (Ann. d. Physik, 26. 1. pp. 120–138, May 12, 1908.)—Measurements of the refractive index are made with a rock-salt prism to 16 μ and with a sylvin prism to 17·7 μ, and the results are considered to extend the exact measurement of wave-lengths from 9·4 μ onwards. Langley's method was employed with a Rowland plane reflection grating of 40 lines to the mm., and a bolometer. The prisms were ground by Zeiss to angles of about 50°, and tables of the values of the refractive index are given, of which the following are the extreme values :—

Wave-length in μ.	Index.	
	Rock-salt.	Sylvin.
0·58932	1·544318	1·490443
15·9116	1·441032	—
17·680	—	1·41403

G. E. A.

1082. *Dispersion of Gaseous Mercury, Sulphur, Phosphorus, and Helium.* **C. Cuthbertson** and **E. P. Metcalfe.** (Roy. Soc., Proc. Ser. A. 80. pp. 411–419, May 25, 1908.)—A novel method was adopted for measuring the indices of refraction for different wave-lengths. The two refractometer tubes were completely exhausted and the apparatus very carefully adjusted, so that the relative retardation of the two light-beams was zero. The apparatus was then illuminated with monochromatic light, *e.g.*, Hg λ5461, and a definite quantity of the material in question allowed to enter one of the refractometer tubes. The number of interference bands crossing the field of view was noted, and then by slowly rotating the drum of the monochromatic illuminator the wave-length of the incident light was changed. This caused the fringes to move across the field, and as each fringe passed the pointer a reading of the drum was taken and the wave-length of the incident light obtained. In this way readings were taken at 30–40 places along the spectrum. The following values were obtained for mercury :—

$$\mu - 1 = 0{\cdot}001755\left(1 + \frac{2{\cdot}265}{\lambda^2 \times 10^{10}}\right).$$

The investigation of sulphur was troublesome owing to the presence of great absorption. The values obtained were—

$$\mu - 1 = 0{\cdot}0010457\left(1 + \frac{2{\cdot}1249}{\lambda^2 \times 10^{10}}\right).$$

If the value of the indices of oxygen and sulphur for λ_∞ be compared they give a ratio of 1 : 3·928, which is strikingly near 1 : 4, the value found by Cuthbertson for similar pairs of elements. The dispersion of phosphorus was found to be given by—

$$\mu - 1 = 0{\cdot}001162\left(1 + \frac{1{\cdot}53}{\lambda^2 \times 10^{10}}\right)$$

and of helium by—

$$\mu - 1 = 0{\cdot}0000347\left(1 + \frac{2{\cdot}4}{\lambda^2 \times 10^{11}}\right).$$

[See Abstracts Nos. 337 and 2175 (1905) and 997 (1907).] E. C. C. B.

1083. *Photography of very weak Spectra and Nebulæ.* **R. W. Wood.** (Astrophys. Journ. 27. pp. 379–381, June, 1908. Phys. Zeitschr. 9. pp. 355–356, June 1, 1908. Translation.)—The exposure of a photographic plate for a short time to a very faint light materially increases its sensibility, so that it can be used for very faint objects, such as weak spectra and nebulæ. A small gas flame a few mm. high is sufficient, but the time of exposure must be found by trial. It is interesting that this exposure to a weak light may be carried out before or after the plate is used for the principal object. The author gives a reproduction of a photograph taken of a band spectrum with an exposure known to be too short. Half the plate was then exposed to a weak light and then developed. The part which was thus treated shows the details of the band, while the other part only shows the head of the band. E. C. C. B.

1084. *Further Measurements of Wave-lengths, and Miscellaneous Notes on Fabry and Perot's Apparatus.* **Rayleigh.** (Phil. Mag. 15. pp. 548–558, April, 1908.)—In a previous paper the author described a modified Fabry and Perot apparatus [see Abstract No. 1060 (1906)], and gave some wave-length determinations made with it. In the present paper is described an interference standard with 5-mm. invar distance-pieces so that the temperature-coefficient is as small as possible. The value obtained previously for the Zn line λ6362·850, is now confirmed, and the wave-lengths of the helium lines, are now given as 7065·200, 6678·150, 5875·625, 5015·680, 4921·930, 4713·144. and 4471·482. A 30-mm. standard is also described with a glass tube having three protuberances at each end as distance-piece. The rings obtained with this apparatus are very small, and the author suggests their magnification in one direction by the use of a cylindrical lens. The author also discusses the correction of a general convexity of the interferometer plates by bending, the bending being produced by forces applied at outside points opposite the contacts with the distance-pieces. He also describes a method of figuring plates for the interferometer by means of HF, surprisingly good results being obtained. Finally the influence upon the rings of the pressure by which the plates are kept up against the distance-pieces is discussed. If P is the force and α the distance through which the points of application approach one another, it is shown that $P = 8{\cdot}80 \times 10^{11} . \alpha^{\frac{3}{2}}$ if a glass plate and an invar distance-piece are employed. Reckoning α in wave-lengths (6×10^{-5} cm.) and P in kg., $P = 0{\cdot}15\alpha^{\frac{3}{2}}$. If P and α undergo small variations—

$$dP = \tfrac{3}{2}(0{\cdot}15)\alpha^{\frac{1}{2}}d\alpha = \tfrac{3}{2}(0{\cdot}15)^{\frac{2}{3}}P\ d\alpha,$$

$dP/d\alpha$ being somewhat dependent upon the total pressure P. In an actual experiment it was found that a pull of 0·78 kg. was necessary at one distance-piece to cause a shift of one fringe at the centre of the system. The calculated value of dP was $-0{\cdot}85$ kg. This only applies to one plate and one point of contact; since there are six contacts, a shift of six bands or more need not cause surprise on remounting, when no special pains are taken to regulate the absolute pressures employed. E. C. C. B.

1085. *Colour Sensibility of Selenium Cells.* **J. Stebbins.** (Astrophys. Journ. 27. pp. 183–187, April, 1908.)—In a previous communication the author described how his determination of the full moon's luminosity ranged from 0·07 to 0·37 candle-metre [Abstract No. 394 (1908)], and it was suggested that the discrepancy might easily be explained if the colour-sensibility curves of the selenium cells used were different. This has now been found to be true, and the present paper gives the results of determinations of the colour curves of the four cells which were used in the work on moonlight. The curves are based on the normal solar spectrum produced by a small grating spectroscope attached to a 12-in. refractor, the centre of the sun's image being kept on the slit. The resulting curves for the four cells are drawn, and show at once divergences sufficient to account for the colour effect. The Giltay cells have two maxima, near $\lambda 6000$ and $\lambda 7000$, while the Ruhmer cell has but one, near $\lambda 7100$. A Giltay cell re-annealed by the writer also shows but one maximum near $\lambda 7100$. The selenium was heated to melting-point, at 217° C., and then annealed between 100° C. and 200° C. It appears that these curves are dependent upon the altitude of the sun, and it may be possible to determine by this means the selective absorption of the atmosphere. C. P. B.

1086. *Pressure-shift of Spectrum Lines.* **W. J. Humphreys.** (Astrophys. Journ. 27. pp. 194–199, April, 1908.)—The author develops a theory that the luminous particle is a strong magnet, and follows Richardson's treatment of the analysis of pressure-shift [Abstract No. 51 (1908)]. The equation given by Richardson requires the change in wave-length by pressure to be positive, or towards the red; to increase directly as the density or pressure of the surrounding gas is raised; and to be directly proportional to the third power of the wave-length examined. The first two requirements agree with the facts of experiment, but the third does not, the average shift being roughly proportional to the first power of the wave-length. Seeing that the only known method of acting on a magnetic field is by means of another, and that a moving electric charge constitutes an electric current, it appears certain that a luminous particle which is influenced by a magnetic field, possesses a magnetic field of its own, due to moving electric charges negative in their nature. The mutual approach of luminous particles would result in the shifting of their spectral lines to red or to violet, and their recession in a corresponding restoration of the lines to their undisturbed positions, those given when the gas is very rare. Provisional computation of the strength of the atomic magnetic field gives it as 45×10^7 c.g.s., much greater than that of the most powerful electromagnet, and this may account for the unsymmetrical broadening observed in many cases. C. P. B.

1087. *Energetics and Chemistry of Band-spectra.* **J. Stark.** (Phys. Zeitschr. 9. pp. 85–94, Feb. 1, 1908.)—The author classifies spectra into three groups, viz.: (1) continuous spectra, including Röntgen rays, (2) line spectra containing spectral series, and (3) band spectra. The first type is attributed to free electrons; the second type to the action of canal- and kathode-rays on resonating substances, *e.g.*, positive ions or neutral atoms containing electrons as an essential part of their structure and capable of vibrating in different ways; the third type is now ascribed to the action of electrons belonging to atoms but capable of being detached—the so-called "valency-electrons." These valency-electrons are in turn classified into three groups which appear to represent (*a*) actual free valencies as in an ion or loose atom, (*b*) saturated valencies, and (*c*) the spare valencies of double or triple bonds. The bands due to these valencies should have, according to the author's view, a definite limit in the ultra-violet beyond which no light is emitted; each electron can only emit a limited series of waves before it settles down to equilibrium, but these may vary somewhat from electron to electron; these consist alternately of waves on the red and on the ultra-violet side, decreasing or increasing in wave-length towards a mean value: confirmation is quoted from the spectrum of cyanogen, which has four bands shading off to the ultra-violet, but also two bands shaded off to the red. Calculations for the unsaturated valencies of negative elements show that the band shaded off towards the red should lie in the extreme ultra-violet at $\lambda < 0{\cdot}18\,\mu$, beyond the reach of the camera, which records from 0·7 to 0·2 μ, whilst the band shaded towards the ultra-violet should be capable of detection: actually most of the bands detected in the spectra of the non-metals are shaded in this direction. The saturated electrons of CO_2 are calculated, on the other hand, to admit band spectra in the infra-red of wave-length shading off from 1·98 μ: actually infra-red bands appear shaded towards longer wave-lengths at 2·6, 4·3, and 12·5–16 μ. The spare electrons of a double bond are calculated to give bands of wave-length from 0·7 μ downwards, thus falling most effectively within the limits of the photographic records: bands of this sort have been widely studied in benzene, quinone, &c., by Hartley and by Baly, as absorption, even if not as emission spectra. The phenomena of fluorescence and the Zeeman-effect are also discussed in relationship to band-spectra, but for these reference must be made to the original. T. M. L.

1088. *Change of the Spectrum of Hydrogen by the continued Action of Strong Discharges.* **E. Rogovskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. 2. pp. 37–41, 1908.)—The author finds that, when strong discharges from an induction coil are passed for some hours through a tube filled with hydrogen, the lines H_α, H_β, and H_δ disappear, and in place of the ordinary spectrum of hydrogen there appears a new spectrum exhibiting many lines and bands. A photograph of this new spectrum is given, and a table of the wave-lengths of the various lines and bands. T. H. P.

1089. *Differences between Anode and Kathode Spectra.* **W. J. Humphreys.** (Astrophys. Journ. 27. pp. 200–203, April, 1908.)—While the results of the many workers on this question differ in minor details, they all agree on the essential point that the metallic lines are most pronounced near the negative pole, and least conspicuous near the positive pole, and that this effect is due to the variation of concentration of the material. The present note outlines the suggestion that the cause of the actual production of the spectrum lines is the bombardment of the positive atoms by the negative corpuscles shot off from the kathode, the action getting weaker and weaker as the distance from the negative pole increases. C. P. B.

1090. *The Resonance Spectra of Sodium Vapour.* **R. W. Wood.** (Phil. Mag. 15. pp. 581–601, May, 1908. Phys. Zeitschr. 9. pp. 450–461, July 15, 1908.)—An extension of the author's work upon the so-called bright-line fluorescent spectrum of sodium vapour. This spectrum is obtained when the vapour is illuminated with white light, and is exceedingly complicated, consisting of many bright lines. If, however, certain individual monochromatic radiations be employed to excite the sodium vapour, a single series of lines out of the fluorescent spectrum is emitted. There are several of these series, and as before shown, each consists of lines situated about 38 Å.U. apart. It is preferable, therefore, to use the term resonance rather than fluorescence spectrum, for they are doubtless excited by the resonance of one or more of the electrons when monochromatic radiation falls upon the system. In the opinion of Larmor a non-radiating system of electrons in steady orbital motion when disturbed by the absorption of a radiation corresponding in frequency to the frequency of one of the electrons, should then emit radiations giving a series of lines equally spaced along a normal spectrum. The author points out certain experimental facts which might influence the determination of the wave-lengths to a slight extent, so that a small divergence from constancy in the wave-length difference between consecutive lines in any resonance series may be expected. In the present paper the wave-lengths of the resonance spectra as obtained with various exciting radiations are given, the wave-lengths being accurately determined to within 0·1 Å.U. Several notable improvements have been made in the apparatus which materially improve the definition obtained. An interesting result was obtained with the lithium arc as exciter, for the red line gives rise to a red resonance spectrum of equally spaced lines, the wave-lengths of which, however, have not been determined. It is interesting also that the Ba line λ4934 excites the same series as the Li λ4972. The wave-lengths of the resonance series all show that the differences between consecutive members tend to increase slightly towards the larger wave-lengths. Plates of the spectra accompany the paper. The author has also made further progress with the channelled absorption spectrum. In the first place it is found that in all probability it extends to as far as 10 μ or 12 μ, as the bolometer shows evidence of powerful absorption in this region. A portion of this spectrum has been photographed with a 21-ft. grating in the second order, and its complexity is found to be very great. A further very interesting discovery is that the D lines can be caused to appear in the emission spectrum by stimulating the vapour with blue-green light from which all yellow has been completely eliminated. The mechanism, therefore, which produces the principal series of lines is connected with, or part of, the very complicated machinery which gives rise to the channelled absorption and resonance spectra. E. C. C. B.

1091. *The Flame Spectra of Iron.* **G. A. Hemsalech** and **C. de Watteville.** (Comptes Rendus, 146. pp. 859–862, April 21, 1908.)—The flame spectra of iron have been examined as obtained with a Bunsen burner, with a Bunsen flame fed with oxygen, and a hydrogen flame with air blast and oxygen blast. The iron vapour is fed into the flame either by Gouy's spraying apparatus or with the authors' own method of passing one of the gases through a bulb in which is maintained a spark or arc discharge between iron poles. Whatever be the method of introducing the iron into the flame, it is found that at the top of the inner cone of the Bunsen flame fed with air a supplementary spectrum is developed which is entirely absent from the oxyhydrogen flame. The flame spectrum of iron shows about 750 lines between λ5000 and λ2250 in the case of the Bunsen flame, and about 210 with the oxyhydrogen flame. The reason why the 540 supplementary lines appear in the first case is not apparent. (Ibid. pp. 962–965, May 11, 1908.)—The authors give in this paper the wave-lengths of the flame spectrum of iron as obtained by forcing a stream of oxygen through a vessel in which a powerful spark is passing between two iron electrodes; the oxygen is then mixed with hydrogen and burnt in a suitable burner [see Abstract No. 411 (1908)]. About 220 lines (whose wave-lengths are given) are observed between the limits λ2488 and λ5871. It was found that the bands due to water vapour were inclined to mask a portion of the iron spectrum. If air was used in place of the oxygen there was a considerable decrease in brilliancy. Almost all the rays of iron seen in the spectrum of Sirius are to be found in this flame spectrum except the enhanced lines. [See also Abstract No. 985 (1908).] E. C. C. B.

1092. *The Red Portion of the Spectrum of Barium.* **V. Hoeller.** (Zeitschr. wiss. Phot. 6. pp. 217–234, May, 1908.)—The author has photographed the Ba spectrum between λ7090 and λ5160 by means of a large concave grating, and gives the wave-lengths compared with those previously observed. He finds the presence of six band-series which are conformable to either Deslandres' formula $N = a - bn^2$, or Fabry's modification of it $N = A \pm (Bn + C)^2$. E. C. C. B.

1093. *Ultra-violet Spark Spectrum of Dysprosium and its remarkable Magnetic Properties.* **G. Urbain.** (Comptes Rendus, 146. pp. 922–925, May 4, 1908.)—The author has observed the spark spectrum of the chloride of dysprosium, and gives in the present paper the wave-lengths of the lines with a maximum error of 0·2 Å.U. between the limits λ2872 and λ4221. He has further measured the magnetic coefficient of the oxide D_2O_3, and finds it to be about 290×10^{-6}, which makes this element the most paramagnetic of all the elements. E. C. C. B.

1094. *Absorption Spectra of Compounds of the Rare Earths at Liquid-hydrogen Temperatures, and their Change in the Magnetic Field.* **J. Becquerel** and **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 592–603, March 27, 1908. Communication No. 103 from the Phys. Lab., Leiden.)—An extension of the investigation of banded absorption spectra at low temperatures. With special apparatus described in detail in the paper, it has been found possible to examine the absorption spectra of several minerals at temperatures down to 14° abs., and also the effect of the magnetic field upon the bands. The present paper contains a preliminary account of the more important results of the observations. Previous observations have shown that on cooling down to temperature of liquid air almost all bands become narrower and divide, and in general their intensity increases. Cooling down to 20° from the temperature of liquid air causes some bands to increase in intensity ; others, however, decrease so that they pass through a maximum near the temperature of liquid air. Whereas in previous experiments it has been shown that down to the temperature of liquid air the width of all bands is proportional to the square root of the absolute temperature, this law does not hold for all the bands when the observations are carried down to 20°. The observations in the magnetic field confirm what has previously been published, for they afford strong support to the argument in favour of the existence of positive electrons. Observations are recorded on the asymmetry of the resolution of the bands and the variation of the magnetic rotation in the neighbourhood of the bands. E. C. C. B

1095. *Zeeman-effect and the Second Law of Thermodynamics.* **O. M. Corbino.** (Accad. Lincei, Atti, 17. pp. 593–597, May 3, 1908. Phys. Zeitschr. 9. pp. 344–346, May 15, 1908.)—A radiating source at the centre of a spherical reflecting sphere reabsorbs the waves after reflection at the spherical surface. The author describes the effect of producing a magnetic field : the equatorial vibrations are reabsorbed as before, their periodicity being unchanged by the presence of the field, but the circularly polarised rays are changed in periodicity and direction of rotation in such a manner that they are no longer absorbed by the source after a single reflection. If, however, the reflecting surface be coated with a quarter-wave plate, each ray, since it traverses the plate twice, has its sense reversed and is now reabsorbed by the source. In the case of two exactly similar sources each at the centre of a sphere, a lens being situated between them in such a way that they are at conjugate foci, the necessary apertures in the spheres being made, on the establishment of magnetic fields, one acting upon each source and the direction of the two fields being at right angles, the author shows that one source absorbs two-thirds of the amount of the radiation crossing the lens in one direction, but the other absorbs only half that amount, thus giving an apparent contradiction to the second law of thermodynamics. The explanation suggested is that the distribution of intensity of radiation between the three components in the Zeeman-effect is not equal, or it may be that the radiation is not entirely thermal but may be of chemical or electrical origin. S. G. S.

1096. *Different Kinds of γ-Rays from Radium and the Secondary γ-Rays they Produce.* **R. D. Kleeman.** (Phil. Mag. 15. pp. 638–663, May, 1908.)—It has previously been shown that part of the γ-radiation can be divided into three groups of rays, and that each of these groups is selectively absorbed by one of three groups of substances [Abstract No. 62 (1908)]. The properties of the secondary rays produced by each of these groups is now investigated. The primary rays fall on a sheet of metal B, used as a radiator, and the secondary rays so excited pass through another sheet of metal C, used as an absorber, into the ionisation chamber. This chamber is screened as far as possible from the primary rays, the small outstanding ionisation being compensated by that produced in another vessel by means of uranium. The substances investigated are Pb, Hg, Zn, Cu, Fe, S, Al, and C. It is found they can be divided into three groups; each group emits rays which differ as a whole from those radiated by the other groups, but the rays from each group are not homogeneous. These three classes are selectively absorbed like the corresponding primary rays, but the secondary radiation is more absorbable than the primary. A given substance radiates those secondary rays in least amount which it best absorbs. This is due to absorption in the radiator itself, the radiation generated in the body of the radiator being absorbed before it reaches the surface. R. S. W.

1097. *Distribution in Electric Fields of the Active Deposits of Radium, Thorium, and Actinium.* **S. Russ.** (Phil. Mag. 15. pp. 601–614, May, 1908. Paper read before the Physical Soc., March 13, 1908.)—Experiments were undertaken to find out whether the quantity of active deposit that goes to an anode in an electric field changes when the pressure is varied. A comparison was made over a range of pressure extending from 0·001 to 10 cm., between the amount of activity imparted to a rod charged positively and then negatively when exposed for the same interval of time to equal quantities of the radium emanation. It was found that whereas the activity of the kathode decreases as the pressure is diminished the anode shows a corresponding increase in activity. The rod which had served as kathode or anode was then made a neutral pole by connecting it to the containing vessel, and diffusion experiments (with no electric field existing in the gas) were then made. There was a marked decrease in the amount of active deposit that diffused on to the rod as the pressure was diminished. A comparison of the activity obtained on a kathode and anode over a range of pressure extending from 0·1 mm. to 1 mm. was made with three gases having widely different densities, namely, hydrogen, air, and SO_2. The results in the case of air show that the activity of the kathode is considerably greater than that of the anode, but that they approach equality as the lower pressure is reached. This effect is more marked in SO_2, while for hydrogen no such difference in activity is observed, just as much active deposit being transmitted to the anode as to the kathode over this range of pressure. Certain anomalies in behaviour were observed, especially with actinium, and these have not yet been fully explained. It is intended to carry out further experiments. J. J. S.

1098. *Absorption of β-Rays.* **O. Hahn** and **L. Meitner.** (Phys. Zeitschr. 9. pp. 821–833, May 15, 1908. Chem. Inst. d. Univ., Berlin, April 8, 1908.)—The absorption of β-rays from most of the radio-active substances except the actinium group has been measured. Three types of β-ray are emitted by the thorium family, viz., that from mesothorium (*i.e.*, Th1 + Th2), from ThA, and the mixture ThB and ThC. The mixture ThB and ThC can be obtained free from ThA by immersing a nickel plate in a solution of the three; ThB and ThC are deposited thereon. Levin's method of treatment with charcoal is the best method of obtaining ThA. The absorption follows an exponential law for ThA, and for ThB + ThC, but deviates therefrom for mesothorium. Of the β-ionisation from the thorium active deposit ThA contributes about 48 per cent. The β-rays from UrX and RaE, also follow an exponential law; the authors, in fact, conclude that all the simple substances each send out one kind only of β-ray, and any deviation from the exponential law indicates a mixture of substances. R. S. W.

1099. *Ionium.* **B. B. Boltwood.** (Amer. Journ. Sci. 25. pp. 365–381, May, 1908. Contribution from the Sloane Phys. Lab. of Yale Univ.)—An account is given of the various chemical operations that have been used to obtain this new substance from uranium ores in a condition free from Ur, Ra, and Ac. In its chemical behaviour it is closely allied to thorium. The earlier experiments [Abstract No. 1882 (1907)] on the growth of radium from ionium have been repeated and verified. It is found that ionium free from other active substances can be obtained as follows: Carnotite is treated with HCl, and several gm. of rare earths from cerite in the form of chlorides are added to the solution. These earths are then separated and again dissolved. This solution is treated with sodium thiosulphate several times, and a small precipitate is obtained which is several thousand times more active than uranium. It contains, at first, UrX, but this disappears with time; only a small proportion of the total ionium present is obtained by this process. Ionium emits α-rays; their range in air at 760 mm. pressure is 2·8 cm. It probably emits β-rays, which are more readily absorbed than those from UrX. The relative activity of ionium and radium in radio-active equilibrium with uranium in a mineral ore is given as 0·34 and 0·45, that of the uranium being unity. This is in good agreement with the activity calculated from the ranges of the α-rays. Some of the pitchblende residues presented by the Austrian Government to the Royal Society have been tested: ionium is found, and in this case free from thorium; the earlier chemical treatment must have brought about this separation. It is possible that Debierne's actinium and Giesel's emanium contained admixtures of ionium. R. S. W.

1100. *Radio-activity of Uranium Minerals.* **B. B. Boltwood.** (Amer. Journ. Sci. 25. pp. 269–298, April, 1908.)—According to McCoy and Ross [Abstract No. 628 (1908)], the uranium minerals have an activity 4·54 times as great as that of the uranium contained in them. The author has examined a number of samples of uraninite, carnotite, and thorianite in order to ascertain the relative activities of the uranium and the various products contained in these minerals. Taking the activity of the uranium as 1, the other activities are as follows: ionium, 0·34; radium, 0·45; radium emanation, 0·62; RaA, 0·54; RaB, 0·04 (?); RaC, 0·91; RaF (polonium), 0·46; actinium products, 0·28; total activity, 4·64 times that of the uranium. If the value, namely, 0·49 × U, to be expected theoretically is taken for RaF, and the max. values found for the activity of ionium (0·35 × U) and the actinium products (0·36 × U), the sum of the separate activities becomes 4·76 × U. These numbers are in good agreement with the corresponding value, 4·69 × U, found from the direct measurement of the uranium minerals. The numerical values of these different quantities will show more or less marked variations when the relative activities are measured in an ionisation chamber of different size and dimensions from those of the electroscope used in the author's experiments, so that, without special definition, the numbers given above cannot be considered as approximating to definite constants. The activity of the uranium seems to be about 2·22 times that of the radium with which it is in radioactive equilibrium. The results show that the amounts of actinium in a mineral are proportional to the quantities of uranium present. It is, therefore, extremely probable that actinium is a disintegration product of uranium.

T. H. P.

1101. *Radio-activity of Potassium and other Alkali Metals.* **J. C. McLennan.** (Nature, 78. pp. 29–30, May 14, 1908.)—Campbell and Wood have shown that potassium salts emit rays of considerable ionising power, and have concluded that this activity is a normal atomic property of the metal. The author has investigated thirty specimens of potassium salts and thirteen samples of other alkali metals, and finds considerable differences in the activity of different samples. Sodium salts and also the metal sodium do not show any activity, yet rock-salt emits an amount of radiation comparable with that obtained from potassium salts. With the exception of ammonium chloride, which shows a feeble activity, ammonium and lithium salts are inactive; a rubidium alum shows slight activity, and cæsium chloride exhibits a just measurable amount. It is concluded that the radiation from potassium salts is not a normal atomic property of the metal. **N. R. Campbell.** (Ibid. p. 55, May 21, 1908.)—In reply to McLennan, Campbell states that his further experiments still support his original conclusions. No separation of the activity has yet been found possible, and all samples of the same pure salt show identical activities. The only difference between the experiments of McLennan and the author lies in the fact that the former places the active material inside the ionisation vessel, while the latter places it outside an aluminium window. If very soft rays are present the difference in the results might be explained.

R. S. W.

1102. *Electroscopic Determination of the Radium present in some "Tufa" Deposits from Hot Springs, Arkansas.* **H. Schlundt.** (Amer. Electrochem. Soc., Trans. 12. pp. 247–252; Discussion, pp. 252–258, 1907.)—The amounts of radium found in various samples of tufa vary from $0·01 \times 10^{-12}$ to 1927×10^{-12} gm. per gm. of tufa. No correspondence exists between the content of radium emanation in the waters of the springs and the radium present in the deposited tufa. [Compare Boltwood, Abstract No. 1877 (1905).]

T. H. P.

REFERENCES.

1103. *Trigonometrical Heights and Refraction Corrections.* **F. R. Helmert.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 26. pp. 492–511, 1908.)—An analytical discussion of the determination of refraction corrections in the neighbourhood of water surfaces.

C. P. B.

1104. *Spectrum near Poles of an Iron Arc.* **W. G. Duffield.** (Astrophys. Journ. 27. pp. 260–271, May, 1908.)—Various workers have for many years back investigated the variations of line spectra of metals at the two poles of the electric arc. The present paper gives results obtained by photographing the spectrum of iron arc with a large Rowland concave grating, with a table of the polar lines measured between λ2360 and λ3493. C. P. B.

1105. *The Mercury Green Line.* **H. Stansfield.** (Nature, 78. p. 8, May 7, 1908.)—The author gives his determinations of the various components of the Hg line λ5461 compared with those of some previous observers. He has observed 17 companions to the principal line, their distance from the principal line being given in milli-angströms. E. C. C. B.

1106. *The Spectra of the Alkali Metals.* **W. Ritz.** (Phys. Zeitschr. 9. pp. 244–245, April 15, 1908.)—The author deals especially with Runge's interpretation of Bergmann's results on the infra-red spectra of the alkali metals, and gives reasons why he thinks Runge's contentions were wrong. [See Abstract No. 605 (1908).] E. C. C. B.

1107. *Absorption Spectrum of Camphor.* **W. N. Hartley.** (Chem. Soc., Journ. 93. pp. 961–965, May, 1908.)—Baly, Marsden, and Stewart found [see Abstract No. 1563 (1906)] that camphor possessed an absorption band—a fact not noticed by the author in 1881. The present paper is an account of the re-examination of this substance and the presence of the absorption band is confirmed. E. C. C. B.

1108. *Influence of Temperature and Magnetisation on Selective Absorption Spectra.* I. II. and III. **H. E. J. G. du Bois** and **G. J. Elias.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 578–588, March 27; 734–740, April 24, and pp. 839–850, May 26, 1908. Communication from the Bosscha Laboratory.)—A preliminary account of the results obtained in an investigation upon the influence of extreme cold and a powerful magnetic field upon the absorption bands given by potassium chromoxalate, uranyl potassium sulphate, praseodymium sulphate, neodymium sulphate and nitrate, erbium nitrate, and samarium sulphate. E. C. C. B.

1109. *New Observations concerning Asymmetrical Triplets.* **P. Zeeman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 566–574, March 27, 1908. Phys. Zeitschr. 9. pp. 340–344, May 15, 1908.)—Observations on the effects described in Abstract No. 783 (1908).

1110. *Change of Wave-length on the Middle Line of Triplets.* I. and II. **P. Zeeman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 574–578, March 27, and pp. 862–864, May 26, 1908.)—The author deals further with the asymmetric magnetic resolution of the line Hg λ5791. He shows that the central line is displaced towards the red, a reproduction being given of the phenomenon in a field of 34,000 gauss. The question whether the asymmetry is twice the shift of the middle line has not yet been answered. [See also preceding Abstract.] E. C. C. B.

1111. *An Explanation of the Asymmetry of the Zeeman Triplet.* **W. Voigt.** (Phys. Zeitschr. 9. pp. 353–354, June 1, 1908.)—The author puts forward the view that the phenomena of asymmetry of the magnetic triplets is to be explained by some of the electrons being coupled together. [See Abstract No. 805 (1908).] E. C. C. B.

1112. *α-Particles from Radio-active Substances.* **R. S. Willows.** (Nature, 77. p. 439, March 12, 1908.)—Townsend's discovery [Abstract No. 662 (1908)] that positive ions produced by Röntgen rays have twice the ionic charge at the moment of formation renders it more probable that the α-rays are doubly charged and hence that they consist of helium atoms. R. S. W.

HEAT.

1113. *Thermal Expansion of Glass for High Temperatures.* **H. F. Wiebe and G. Moeller.** (Zeitschr. Instrumentenk. 28. pp. 187–189, May, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—In a previous investigation [see Abstract No. 478 (1902)] the coefficients of expansion for some Jena thermometer glasses were determined. Use is made of these to find the coefficient for glass scales at 0°, 100°, 200°, 300°. The scales used were made by four different firms. The coefficients are found to rise considerably with temperature, as is shown in the expression—

$$\beta = 10^{-6}\left\{860{\cdot}8\,\frac{t}{100} + 40{\cdot}0\left(\frac{t}{100}\right)^2\right\}.$$

These results are the mean values for the different makers. P. E. S.

1114. *Expansion and Specific Heat of Metals.* **E. Grüneisen.** (Ann. d. Physik, 26. 1. pp. 211–216, May 12, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—The author observes that the quotient of the coefficient of expansion and the specific heat of a metal is roughly independent of temperature. Some values of $\alpha \times 10^{-6}/C_p$ are given in the following table, deduced from published data :—

Temperature C.	−173.	−150°.	−100°.	−87°.	0°.	100°.	300°.	400°.	500°.	800°.	875°.	1,200°.
Aluminium	(107)	—	109	—	110	112	119	—	—	—	—	—
Wrought Iron	—	—	—	105	109	109	104	—	89	—	112	—
Nickel	—	—	—	117	120	121	114	—	126	—	—	—
Copper	—	—	—	174	177	180	—	179	—	—	—	—
Palladium	—	192	191	—	198	197	—	—	—	—	204	—
Silver	(319)	—	—	329	327	331	—	—	350	342	—	—
Iridium	—	—	—	—	205	212	—	—	—	—	—	207
Platinum	—	269	268	—	280	277	—	—	—	—	267	—

The greatest irregularities are found in Fe, Al, and Ni in the neighbourhood of their transformation-points. It is to be expected that metals of either high atomic volume or high atomic weight, as Na, K, Sn, Au, Tl, Pb, will have but slightly variable coefficients of expansion. The above empirical relation does not appear to be valid for liquids, *e.g.*, mercury. F. R.

1115. *Measurement of very Low Temperatures.* XIX. *Derivation of the Pressure-coefficient of Helium for the International Helium Thermometer and Reduction of the Readings on the Helium Thermometer to the Absolute Scale.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 589–592, March 27, 1908. Communication No. 102*b* from the Phys. Lab., Leiden.)—Taking the absolute zero as previously so that T 0°C. = 273°·10, the author calculates the pressure coefficient of the international helium thermometer, *i.e.*, the mean relative pressure-coefficient from 0° to 100° C., for helium with density belonging to the zero pressure of 1,000 mm., and finds it to be 0·0036616. This does not agree with the value found by Travers, Senter, and Jacquerod, but if the differences found by these authors between their helium and hydrogen thermometers are reduced to the absolute scale and the correction applied, their value is found to be 0·008616 in one case and 0·0036614 in another. The former is obtained without extrapolation, and is therefore more reliable. This result explains the too large differences found by Travers, Senter, and Jacquerod, and confirms the author's own result.

E. C. C. B.

1116. *Measurement of very Low Temperatures.* XX. *Influence of the Deviations from the Law of Boyle-Charles on the Temperature measured on the Scale of the Constant-Volume Gas Thermometer.* **H. Kamerlingh Onnes** and **C. Braak.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 743–744, April 24, 1908. Communication No. 102*d* from the Phys. Lab., Leiden.)—The authors find that, owing to miscalculation, the value 0·0036629, previously given by them [Abstract No. 1177 (1907)] for the coefficient of pressure of the hydrogen thermometer at 1,090 mm. pressure at 0°, is incorrect, the true value being almost exactly 0·0036627. Corrections are given for some of their published results, which have been re-calculated by means of the above new coefficient.

T. H. P.

1117. *Condensation of Helium by Expansion.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 744–747, April 24, 1908. Communication No. 105 from the Phys. Lab., Leiden.)—By expanding helium in a thick-walled glass tube placed in a non-silvered vacuum glass containing liquid hydrogen, a dense, grey cloud appeared from which there separated solid masses floating in the gaseous helium. These masses, which slide down the walls of the tube and rapidly vanish without any sign of melting, were thought to be solid helium. Further experiments show, however, that the phenomenon is due to the presence of traces of hydrogen in the helium.

T. H. P.

1118. *Combustion of Gases by Incandescence in presence of Oxidisable and of Non-combustible Substances.* **J. Meunier.** (Comptes Rendus, 146. pp. 757–758, April 6, 1908.)—The behaviour of incandescent substances in explosive gases and the mechanism of flameless combustion are to be explained by the localisation of the combustion on the surface of the substance [see Abstract No. 945 (1908)]. Different results are obtained according as the incandescent substance is oxidisable or non-combustible. When a spiral of pianoforte wire 1 m. in length and 0·885 gm. in weight is heated electrically to redness in 100 c.cm. of a mixture of 9·2 per cent. of methane, 18·5 of oxygen, and 72·3 of nitrogen, it increases in weight by 0·0115 gm., corresponding with 8·5 c.cm. of oxygen, whilst the residual gas contains 10 c.cm. of oxygen and no CO_2. As the spiral only occupies a volume of 40 $mm.^3$, the oxygen absorbed cannot be brought into contact with the metal by convection alone, so that there must be actual attraction of the gas by the incandescent metal. Similar behaviour is exhibited by a lead wire. Platinum and nickel and also certain oxides undergo flameless combustion when heated and placed in an inflammable gaseous mixture, but in general the metals do not remain incandescent under these conditions. The intensity of the incandescence depends not only on the nature of the substance, but also on the composition of the inflammable gas. The ashy skeleton of a half-burnt match becomes incandescent when placed at a distance of 4 mm. from the apparent flame of a candle, and vividly so at a distance of 1–2 mm.

T. H. P.

1119. *Flameless Combustion and its Application to Lighting by means of Incandescent Mantles.* **J. Meunier.** (Comptes Rendus, 146. pp. 864–866, April 21, 1908.)—When the mantle of an incandescent gas-burner becomes incandescent, the flame which served to light it disappears and, inversely, if the flame reappears, the incandescence diminishes considerably in intensity. The temperature of the mantle is far higher than that of the flame or that of the gaseous layer surrounding it at a distance of 2 or 3 mm. [compare preceding Abstract]. Auer's theory, according to which the incandescence is produced by an extremely rapid succession of reductions and oxidations of one of the oxides of the mantle, is criticised, the author regarding reduction as impossible. Combustion by incandescence causes considerable lowering of the inferior limit of the inflammability of gases. T. H. P.

1120. *Calculation of Molecular Dimensions.* **H. Sirk.** (Ann. d. Physik 25. 5. pp. 394–404, April 28, 1908.)—According to the kinetic theory, the absolute number of molecules in 1 cub. mm. of a gas is $N = 1/320L^3x^2$, where L is the mean free path and x is the fraction of the volume actually occupied by the molecules. Assuming the postulate of Avogadro, it follows that L^3x^2 should be constant for different gases. The author calculates the value of L^3x^2 for 87 substances. For the determination of x use was made, in the first place, of the van der Waals' equation in which $x = b/4$; use was also made of the Clausius-Mosotti relationship, $x = (K - 1)/(K + 2)$, and from the values of the refractivities $x = (n^2 - 1)/(n^2 + 2)$. The results of the calculations show that the values of L^3x^2 are greater when x is obtained from the kinetic gas theory than when obtained by optical methods. The first method gives numbers for L^3x^2 which in 13 cases diminish with rise in the value of the critical temperature, whereas the second method gives numbers which are approximately constant. This is in harmony with the experiments of Guye. Calculations have also been made on the basis of the experiments of J. J. Thomson and H. A. Wilson, which give for N the value 6×10^{16} to 3×10^{16}, and hence $L^3x^2 \times 10^{20} = 5{\cdot}1$ to $10{\cdot}4$. Similarly Planck has obtained values for N, based on his electromagnetic theory of radiation, equal to 5×10^{16}, which gives for $L^3x^2 \times 10^{20}$ the value of 6·2. The numbers are calculated by the author with the values of x obtained from refractivity methods. A. F.

1121. *Behaviour of Nuclei of Pure Water.* **C. Barus.** (Amer. Journ. Sci. 25. pp. 409–412, May, 1908.)—For very small fog particles suspended in dust-free air saturated with water vapour the dissipation by evaporation is much more important than that by subsidence. In the author's fog-chambers the transition occurs for the number of nuclei per cm.³ $n = 200{,}000$, or the diam. of fog particles $d = 0{\cdot}0003$ cm., when about one-half evaporate and one-half subside. Fog particles precipitated on solutional nuclei (phosphorus) evaporate to persistent water nuclei without other loss than is attributable to subsidence and in a small degree to time losses. There is no loss by complete evaporation. In the case of fog particles precipitated on the nuclei of water vapour in dust-free air evaporation is almost without residue, the yield of water nuclei being but 0·004 of the number of fog particles when $d = 0{\cdot}00016$ cm., increasing to 0·036 when $d = 0{\cdot}00032$ cm. The persistence of water nuclei obtained from the nuclei of water vapour is much increased by accelerating the evaporation of the fog as soon as formed. When the rate of evaporation is increased by compression the number of water nuclei may be as large as 5 per cent. to over 20 per cent. of the fog particles evaporated. The loss of nuclei by decay in the lapse of time, and the effect of changes in the drop of pressure on sudden exhaustion have no causal bearing on the production of water nuclei by rapid evaporation. They merely modify the number. Similarly the effect of subsidence is secondary. Residual water nuclei may, on rapid evaporation, exceed the order of 10^{-6} cm. in diam. two or three times; or on slow evaporation they may fall below 5×10^{-7} cm. and yet persist for half an hour or more. Under any circumstances they are graded. An hypothesis of a statistical character is suggested, viz., that the molecule of liquid water is composite, consisting of virtually more volatile and less volatile constituents. In the case of fog particles when the evaporation is reduced to extreme slowness, it may be that all groups of molecules evaporate together at about the same rate, and that therefore the residue, *i.e.*, the persistent water nuclei, are present in least amount. When, however, the evaporation is forced or accelerated by the heat due to compression, the more volatile constituents of the fog particles evaporate faster than the less volatile, and there is a correspondingly greater residue of persistent water nuclei because of this concentration of the less volatile molecular aggregates of water in each fog particle. Also more persistent nuclei are obtained by the evaporation of large fog particles, for then the opportunities for concentrating the less volatile aggregates are enhanced. Experiment appears to support these deductions. J. J. S.

1122. *Elementary Theory of Brownian Movements.* **A. Einstein.** (Zeitschr. Elektrochem. 14. pp. 235–239, April 24, 1908.)—The author examines the diffusion process in a non-dissociated diluted solution in its dependency upon the distribution of the osmotic pressure in the solution and on the mobility of the solute with regard to the solvent. The containing vessel is supposed to be provided with a semi-permeable diaphragm (separating two solutions of different concentrations) in the shape of a movable piston. Assuming that the molecule of the solute is large by comparison with the molecule of the solvent, a formula is deduced for the diffusion coefficient, which depends only on the viscosity of the solvent and the diam. of the dissolved molecules. This argument is then extended to the irregular movements of dissolved particles and of any small suspended particles. The molecular theory of heat leads to the same conclusion, and the formula covers also the migration of ions. [Compare Abstracts Nos. 1909 (1905) and 743 (1906).] H. B.

1123. *Application of the Laws of Similitude to the Propagation of Detonations.* **Crussard** and **Jouguet.** (Comptes Rendus, 146. pp. 954–956, May 11, 1908.)—The reader of this paper should first make himself acquainted with the earlier paper by one of the two authors (Journ. de Mathemat. pures et appliquées, 1905–6), "On the Propagation of Chemical Reactions in Gases." In the present paper the movements of molecules owing to their great velocity are assumed to be adiabatic throughout. They will also be supposed to exist in the first part (the gas under experiment consisting of two parts) without combustion, in the second either without it or with it, subject to the law of dissociation. The equations for the two parts are then (1)...$(1/\rho)dp/dx = -j_x$, with similar ones for y and z; (2) $p = f(\rho_1 a_1 T)$ and $r_a da/dt + r_\rho d\rho/dt + cdt/dt = 0$. Also for the first part $a_1 = \text{const.}$, for the second part, either $a_2 = \text{const.}$ or $g(l_2, a_2, T) = 0$, the law of dissociation. Here $f + q$ are functional forms. These equations, the writers say, show the possibility in the same mixture of "similar" movements in which the velocities, densities, chemical variables, temperatures, and pressures shall all be the same. For example, if waves of explosion and combustion are excited in an indefinite mass by two different but unequal charges, the two experiments give "similar" results, with the above-mentioned quantities the same in the two cases. There is, therefore, say the writers, no *limiting charge.* The reasoning supposes that the wave of explosion and combustion, once established, continues permanent. This, however, in the case of spherical waves is impossible. It is therefore a necessary condition that we compare only similar systems. This condition is not fulfilled if we excite two different explosions in the same tube by two unequal charges not filling the section of the tube. In this case, before the plane wave comes into existence, there will be more or less spherical waves, of greater importance as the charge is smaller. Suppose now that at the same temperature, pressure, and dimensions two experiments are made, in which the same gaseous mixture is diluted in the same volume, first with one, secondly with another of two different inert gases, having the same molecular specific heat. Gibbs's theory of mixtures is founded on Avogadro's law, and the law that one gas acts as a vacuum to another. If a and T have the same values in the two cases, but ρ varies as the molecular weight, the two functions f and q in the above equations have the same value, while U_1, U_2, r_ρ, r_a, and c vary inversely as the molecular weight. The two experiments are similar, and the velocities vary inversely as the square root of the molecular weight. This, the writers say, is confirmed by Dixon's experiments, and the result is rather to confirm Gibbs's theory of gas mixtures than to confirm any particular theory of explosions. S. H. B.

REFERENCES.

1124. *Boiling-points of Metals, deduced from Moissan's Results.* **O. P. Watts.** (Amer. Electrochem. Soc., Trans. 12. pp. 141–152; Discussion, pp. 152–154, 1907.)—The relative values are collected from the results obtained with metals and alloys by Moissan and his collaborators, and the probable values tabulated when the boiling-points of Zn and Cu are taken as 940° C. and 2,100° C. respectively (Féry). F. R.

1125. *Radiation at Room Temperature.* **W. W. Coblentz.** (Phys. Zeitschr. 9. pp. 64–66, Jan. 15, 1908. From the English.)—A discussion is given of the results of various earlier investigators, and then an account of the observations made by the author upon the energy distribution in the spectrum. A Rubens thermopile was employed. J. J. S.

1126. *Vapour-pressure of Carbonic Acid.* **J. Zeleny.** (Phys. Rev. 25. pp. 490–491, Dec., 1907.)—Gives further particulars as to the nature of the gas used, in view of du Bois' explanation of the differences between his own and the author's results. L. H. W.

SOUND.

1127. *A Gas Microphone.* **A. Fiorentino.** (N. Cimento, 15. pp. 177–181, Feb.–March, 1908.)—If a circular plate is impinged upon by waves of the frequency of one of its natural vibrations, that vibration is not excited in it unless alternate ventral segments are covered up. This can be done by cutting out a ring of suitable sectors and mounting them very close to the plate. A small gas-jet is burnt very close to one of the ventral segments, and another vertical tube, drawn out to a capillary 1 mm. wide, points down to the jet from above. The capillary is connected with a hearing tube. The vibrations of the plate are powerfully reinforced. E. E. F.

1128. *Absolute Determination of Sound Intensity.* **W. Zernov.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. 3. pp. 70–83, 1908. Ann. d. Physik, 26. 1. pp. 79–94, May 12, 1908.)—The method of measuring the intensity of vibrations by the torque they exert upon a disc, put forward by Rayleigh, has been used for relative measures of sounds by Grimsehl and by Lebedew. W. König has given a theory of the turning of a disc-like ellipsoid of rotation under the influence of fluid motions. The present author has experimentally tested König's theory by an electrically driven tuning-fork, one of whose prongs carried a hollow cylinder, inside which the ellipsoid was suspended by a torsion wire of platinum. He thus found that König's theory was fully confirmed to the limits of the experimental errors, viz., $0{\cdot}5$ per cent. To measure the intensities of sounds due to the human voice, a Rayleigh disc was used, consisting of a mirror suspended by a quartz fibre, and having a very short period. For loud shouts and powerful singing tones at 2 m. from the source, this disc showed the energy density to vary from $0{\cdot}3 \times 10^{-4}$ to 2×10^{-4} erg per c.cm. E. H. B.

1129. *Control of Loudness from Bowed String.* **H. N. Davis.** (Phys. Rev. 26. pp. 351–352, April, 1908. Abstract of paper read before the Amer. Physical Soc.)—According to the Helmholtzian theory of the violin string, the motion of the part of the string in contact with the bow can be represented by a simple zigzag, if values of the time are plotted as abscissæ and the corresponding displacements of the point bowed as ordinates. One slope of the zigzag represents that part of the motion which is in the direction of the bowing, and during it the string is sticking fast to the bow and moving with its velocity. The ratio of the corresponding time-interval (a) to the period (τ) is determined solely by the distance of the point bowed from the ends of the string; if this point is one-seventh of the length from the bridge a is six-sevenths of τ, and so in general. Therefore the amplitude at the place bowed is wholly determined when the position and speed of the bow are given. When the bow is brought nearer the bridge the amplitude at the place bowed increases, and it is easy to see that the amplitude at the centre of the string increases still more, so that the sound should be louder than before. This is indeed the case, as every violinist knows. If, however, it be desirable not to move the bowing point, then, on the Helmholtzian theory, the amplitude of the string and the loudness of the sound produced are wholly determined by the speed of the bow, and are not affected by a change in its pressure—a conclusion that does not seem to be in agreement with experience. The author then puts forward an explanation of the discrepancy, based on results of previous work, an account of which was read but is not yet published. It was there found that to such bowing-speed corresponds a certain bowing-pressure below which the normal Helmholtzian form cannot be maintained, and that this critical pressure varies very nearly as the bowing-speed. It can be considerably exceeded without changing the nature or magnitude of the vibration, but a violinist would ordinarily use as small a pressure as his bowing-speed at the moment would allow, both because of the scratching which too great a pressure causes, and to avoid undue fatigue. Therefore, even if loudness is determined by bowing-speed alone, a greater bowing-speed would always be accompanied by a greater pressure, and this would seem to be the cause of the loud tone. The author is, however, led to believe that the actual motion of a violin string is usually not of the normal Helmholtzian type, but of a special type on which he hopes to make further investigations. E. H. B.

1130. *Perception of Sound Direction.* **C. S. Myers** and **H. A. Wilson.** (Roy. Soc., Proc. Ser. A. 80. pp. 260–266, April 6, 1908.)—This work is in continuation of that by Rayleigh and by More and Fry on the same subject [see Abstracts Nos. 444 and 1040 (1907)]. The apparatus here used was like that of More, but permitted a continuous variation in the phase-difference produced at the two ears. This was obtained by letting the sound from a tuning-fork enter at a side branch in a long tube which could slide along into others at its ends so as to simultaneously shorten the path to the right ear and lengthen that to the left, or *vice versâ*. The results obtained suggested to the authors that while a difference of phase may be a primary cause of lateral effects, yet it acts by producing a difference between the intensities of the sound inside the ears. The supposition that some of the sound entering an ear gets across through the head to the opposite internal ear, will, they believe, allow a simple explanation of the phenomena to be given.

E. H. B.

1131. *Shortest Time perceived by Ear.* **B. V. Hill.** (Phys. Rev. 26. pp. 333–334, April, 1908. Abstract of paper read before the Amer. Physical Soc.)—Through the primary of a small induction coil were connected two parallel circuits, each under the control of one of the keys to be liberated by a falling weight. The secondary of the coil was connected through a cable to a telephone receiver in a distant room, signals being arranged between the subject in this room and the operator of the falling-weight apparatus. The parallel resistances were adjusted till the subject was unable to distinguish which of the two circuits was opened. A series of stimuli were then given, successive and simultaneous impulses being given at random, till the answers of the subject were as often incorrect as correct. The smallest interval which seemed distinctly perceived as such was thus found to be 0·007 sec., which agrees well with previous work. The secondary of the induction coil was connected to an oscillograph which traced a curve on a sensitive film driven at high speed by a motor and indicating down to 0·0015 sec.

E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1132. *Electrical Resistance of Moving Matter.* **F. T. Trouton** and **A. O. Rankine.** (Roy. Soc., Proc. Ser. A. 80. pp. 420–435, May 25, 1908.)—The question of relative motion between the earth and the neighbouring ether has been under discussion for many years. The experimental tests hitherto made have all resulted negatively. The present experiment is not different from the others in this respect, yielding, as it does, no definite information on the main point. Indirectly the aim was to measure the direction and magnitude of the ether-drift, the actual method having been to attempt to demonstrate the existence of the Fitzgerald-Lorentz shrinkage, which has been supposed to mask the effect in the direct experiments of Michelson and Morley and of Trouton and Noble. If this shrinkage is real, it is in the present experiment obscured by some other exactly compensating change or changes, no effect approaching that to be otherwise expected having been observed. The principle of the measurement is very simple. Let a wire of length l and cross-sectional area a move through the ether lengthwise at speed v. Let ρ be its specific resistance and R its total resistance. Then $R = \rho l/a$; whence, by logarithmic differentiation $\delta R/R = \delta\rho/\rho + \delta l/l - \delta a/a$...(1). Now suppose that the wire is turned through a right angle, so that its length is perpendicular to the velocity v. According to the Fitzgerald-Lorentz shrinkage hypothesis, the length of the wire will be thus increased by a small amount δl, such that $\delta l/l = \frac{1}{2}\beta^2$, where β is the ratio of v to the speed of light. But one dimension of the cross-section is now diminished, so that $\delta a/a = -\frac{1}{2}\beta^2$. Hence (1) now gives $\delta R/R = \delta\rho/\rho + \beta^2$...(2). Thus, if ρ is unchanged by the direction of motion, so that $\delta\rho = 0$, we have $\delta R/R = \beta^2$. Thus on this supposition the resistance of a wire with its length perpendicular to the ether-drift will be greater than when parallel in the ratio $(1 + \beta^2) : 1$. On the other hand if, as here experimentally found, no change of total resistance is detected, two alternatives present themselves. Either there is no change of length of the kind supposed, or the specific resistance changes in such a way as to compensate it. In the latter case the law of change would be that the specific resistance of a material to a current flowing parallel to the ether-drift is greater than that at right angles in the ratio $(1 + \beta^2) : 1$. At the close of the paper it is shown that this change of specific resistance is just that which accords with the electronic theory of metallic conduction and the Lorentz theory as to the mass of the electrons. The experiment was carried out with a special form of Wheatstone bridge arrangement in which the wires forming the four resistances were parallel to the sides of a square. The delicacy used was such that it is asserted no change in total electrical resistance exceeding 5×10^{-10} of the whole amount occurred by any change of position relative to its motion through space, and this is 2 per cent. of the change to be looked for if ρ were constant. E. H. B.

1133. *Self-inductance according to the Electron Theory.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 850–854, May 26, 1908.)—The kinetic energy of an electric current is partly electric and partly magnetic. It is customary when calculating self-inductance to take into account the magnetic energy only. Hence confusion arises when physicists refer to the existence of self-inductance in order to make the existence of the kinetic energy of electrons more intelligible. Self-inductance should be explained from the kinetic energy of the ions and not *vice versâ*. Suppose that a lump of metal contains a great number of positively and negatively charged particles and that the total charge is zero. If the lump of metal be moving we must ascribe to it a certain electromagnetic mass which is equal to the *sum* of the electromagnetic masses of the positive and negative particles. It must be carefully noticed, however, that the energy of the current is not equal to $(1/2)\Sigma mv^2$, where m is the mass of a particle and v the mean velocity which is given to it by the e.m.f. In the case of the moving lump of metal the positive and negative particles move in the same direction, and so at all points in space the magnetic and electric forces due to the ions nearly cancel one another. The forces are only appreciable in the immediate neighbourhood of an ion. On the other hand, when a current is passing through a metal the magnetic forces exerted by most of the ions will be in the same direction. If N be the number of ions in unit volume, and H the magnetic force at a point due to one of them, the energy per unit volume at the point will be N^2H^2. This energy, therefore, is not the sum, but is nearly N times the sum of the amounts of energy at that point due to individual ions. Hence the energy of the current is much greater than $(1/2)\Sigma mv^2$. The self-energy of a current i may be expressed by the formula $(1/2)(L + L')i^2$, where L is the value usually calculated for the self-inductance and $(1/2)L'I^2 = (1/2)\Sigma mv^2$. If we assume that the current is transferred by only one kind of ion, then for each unit volume of the metal $(1/2)\Sigma mv^2 = (1/2)Nmv^2$. If the "lump of metal" be a circular wire of radius R with a circular cross-section of radius r, we have $i = \pi r^2 Nev$ and—

$$L' = \frac{\pi r^2 . 2\pi R . Nmv^2}{(\pi r^2 Nev)^2} = \frac{2R}{r^2}\frac{m}{Ne^2}.$$

For bismuth J. J. Thomson finds that $Ne = 0{\cdot}11$. Putting $e/m = 1{\cdot}865 \times 10^7$, we find that $L' = (R/r^2)10^{-6}$. The same result is obtained by using the numbers found by Drude for the electrons per cm.^{3}. If $R = 25$ cm. and $r = 0{\cdot}05$ cm., Rosa and Cohen [see Abstract No. 271 (1908)] have found that $L = 654{\cdot}40496$; for a circular wire of bismuth of the same dimensions we find that $L' = 0{\cdot}01$, approximately. Notwithstanding the perfect agreement between Thomson and Drude's figures, the author thinks it advisable to investigate a further method of evaluating L′. Using a result of Hagen and Rubens, he finds for the conductivity of a metal the expression $n(2Ne^2l)/mu$, where u is the mean velocity of the heat-motion of the electrons, l the path length, and n a constant (1/4 according to Drude, and $\sqrt{2/3\pi}$ according to Lorentz). At $T = 300$, $u = 1{\cdot}75 \times 10^6$, and $\rho = 6{\cdot}14 \times 10^{-4}$ for silver. Assuming $l = 10^{-4}$, he finds that $L' = (R/r^2)5 \times 10^{-8}$. This value is about one-twentieth the value found above for a circular wire of bismuth. These values for L′ are only rough approximations, but they make it probable that when L is large, for example, in a coil with many turns, L′ is negligibly small. It is anticipated that when a current passes through a gas, as, for instance, in a Röntgen tube, the value of L′ will be relatively large. In this case the high value of the velocity of the ions will make the kinetic energy very high. This will increase very appreciably the self-inductance of the circuit in which the tube has been inserted. A. R.

DISCHARGE AND OSCILLATIONS.

1134. *Carriers of Positive Electricity.* **J. J. Thomson.** (Engineering, 85. pp. 518–519, April 17, 1908. Electrician, 61. pp. 24–25, April 17, 1908. Paper read before the Royal Institution, April 10, 1908.)—A lecture concerning the nature of positive electricity, the object being to examine whether it exhibits anything approaching in simplicity the negative corpuscles. The deflection method and Stark's method, based on Doppler's principle, are given as showing how the velocity of the positive rays in a vacuum tube is measured. A tube with perforated kathode for showing these positive rays is described. It is found, on reversing the signs of the potentials on the electrodes, that positive particles are still found near the perforation, and in some cases these are moving up the field. To test whether this velocity is due to an explosion in the atom the particles are allowed to move against the field produced by a gauze, and their velocities are measured with this field on and off. No change is produced by the field. The particles are next shot through a smal hole in a wedge-shaped kathode, the back face of the metal being inclined to the direction of motion. Parallel to this face is another metal sheet containing a coaxial hole; the field between these plates should deflect the particles from their path, but experiment shows they come through as before. It is concluded that the particles get through in an uncharged condition; they pick up a negative corpuscle at the kathode, and later on lose this charge. The velocity they acquire while negatively charged is sufficient afterwards to carry them against the field. The lecturer's theory of the arc is given; the arc discharge is viewed, not as a discharge of electricity through a gas, but rather as a discharge of electricity from an incandescent solid. R. S. W.

1135. *Vacuum Tube Discharge.* **P. Villard.** (Journ. de Physique, 7. pp. 325–361, May, 1908.)—The effect of magnetic and electric fields and of independent sources of ionisation on the positive column is investigated. The chief conclusions are the following: The positive column does not behave as if it were a collection of charged particles—positive ions—independent of each other, but rather as a flexible and extensible conductor. It is more stable as the current is more intense, but is destroyed by excessive ionisation, as in the Faraday dark space. The electric arc, the oscillating spark, and the electrodeless discharge are intense discharges reduced to the positive column, the negative glow and kathode-fall being absent. The transport of electricity by free ions does not produce the light in the discharge. R. S. W.

1136. *A Rectification Effect in a Vacuum Tube.* **H. A. Perkins.** (Amer. Journ. Sci. 25. pp. 485–492, June, 1908.)—The author noticed that a tube exhausted to about ½ mm. pressure showed ionisation when placed in an alternating electrostatic field of low frequency and comparatively low potential. In addition a direct current was sent through a galvanometer connected with two terminals sealed into the ends of the tube. The alternating field was obtained by connecting a ring surrounding the tube with one terminal of a 2,000-volt transformer excited by alternating current obtained from the public supply mains. The other high-pressure terminal of the transformer was earthed. The tube was about 20 cm. long and was 2 cm. in diam. A Kelvin galvanometer was used to measure the current. Its resistance was 5,800 ohms, and 1 cm. deflection on the scale was produced by 5×10^{-8} amp. When the switch was closed a faint glow appeared in the tube, and when the galvanometer key was depressed a constant deflection was produced. When the ring was moved from one end of the tube A to the other B through the middle point M the following effects took place: At A the current was practically zero; it then increased to a maximum positive value at a point near M. At M it was zero, but rapidly obtained its greatest negative value when M was passed, and finally became zero again at B. A Kelvin multicellular voltmeter placed between A and B gave maximum readings when the ring was at A or B, and gave a zero reading when the ring was at M. The author, making the assumptions that there is a uniform potential gradient between the rings and the ends of the tube and that most of the ionisation occurs near the ring, gives a theory which explains (1) why a direct current is caused by the alternating electrostatic field; (2) why the positive pole of the tube is always the one nearest the exciting ring; (3) why the maximum currents are obtained at two points near to and equidistant from M; and (4) why the effective terminal voltage of the tube is a maximum when the current through the galvanometer is a minimum, and *vice versâ*. A. R.

1137. *Wehnelt Kathodes in High Vacua.* **A. Wehnelt.** (Phys. Zeitschr. 9. pp. 134–135, Feb. 15, 1908. Physikal. Inst. d. Univ., Berlin, Jan. 11, 1908.) —The author writes to contradict Soddy's assumption [Abstract No. 108 (1908)] that in his observations on the degree of exhaustion in discharge tubes with oxide kathodes he implied that the large currents involved were sustained by electrons driven out from the glowing oxides. Wehnelt has never held this view. In the best possible vacuum, however, in tubes with oxide kathodes a pure un-self-supporting current can occur, the total current being sustained by the electrons sent out from the glowing oxides. This is even now Wehnelt's view, and the fact is shown by the existence of distinct saturation currents whose strength at small pressures (under 0·1 mm.) is independent of these. When the pressure rises above 0·1 mm. the characteristic curves show no distinct saturation current. At this pressure there appears ionisation through collision of ions. The current strengths which are obtained with pure electron conduction per sq. cm. of the glowing oxide surfaces are only small. The greatest value obtained by the author at a temperature of 1,367° was about 10^{-3} amp. With the independent current in rarefied gases the situation is quite different. In this case the current is sustained by the ions (or electrons) produced by itself. When glowing oxide kathodes are used with this kind of current these have only the effect according to their temperature of lowering more or less the kathode-fall. The necessary number of electrons is only small compared with the number of ions and electrons which are produced by the current itself through the gas. Thus with the independent current in a tube with oxide kathodes currents of about 2 to 3 amps. for each cm.^2 of the glowing oxide surface can be sent through. The current sustained at the same temperature by the electrons proceeding from the oxide attains the value of only 10^{-3} amp. In order to send strong currents through discharge tubes the pressure must always be relatively small, since the potential gradient of the positive column increases quickly with the pressure. When the pressure in the tube is so small that with small e.m.f.'s (110 to 220 volts) no ionisation through collisions takes place, then also no independent current exists. In kathode-ray tubes with oxide kathodes the pressure must also be somewhat low, since at high pressures the kathode-rays are diffuse and give no sharply marked fine bundles of rays. This form of discharge also is a self-sustaining one which only takes place when so much gas is present that strong ionisation through encounters of ions is possible. [See also Abstract No. 448 (1908).] J. J. S.

1138. *Stability and Potential Difference of the Alternating-current Arc between Metals.* **C. E. Guye** and **A. Bron.** Archives des Sciences, 25. pp. 453–473, May, and pp. 549–576, June, 1908. (Comptes Rendus, 146. pp. 1090–1093, May 25, 1908.)—Very discordant results have been obtained by various experimenters. This is due to the complex nature of the phenomena and the great difficulty of obtaining stability, more particularly when the arc is long and the current small. The ratio of the period of burning to the period of extinction is of great importance. The p.d. varies largely with the stability of the arc. Every cause, like the pressure of the gas, currents of air, cooling, diminution of inductance and of the resistance of the circuit, &c., which tends to increase the period of extinction, raises the p.d. difference. By using an enormous reserve of pressure (20 kilovolts on open circuit) and by keeping the electrodes at temperatures very near their fusing-points arcs of great stability were obtained. In these conditions the period of extinction became negligible and the explanation of the results obtained was simple and quite in accordance with the usual ideas of the mechanism of the arc. It was found that when other things were the same the minimum p.d. tended to a constant value *whatever the nature of the metals might be*, provided that they were not easily volatilised. The following table is given :—

Platinum	472 volts	Copper....................	(479) volts
Gold	473 „	Nickel...............	472–485 „
Palladium	468 „	Iron........................	477 „
Silver	477 „	Aluminium	455–500 „

The experiments were carried out in air, at a pressure of 40 cm. of Hg, the distance between the electrodes being 4 mm. and the current 0·1 amp. at a frequency of 50 ∿. The Ni and Al arcs were the most unstable. The greatest divergences were obtained for copper. In air 502 volts was found. This was probably due to the layer of oxygen round the electrodes increasing the instability. In nitrogen the numbers found for Cu and Pt were practically the same. Experimenting on metals which give off large quantities of vapour the p.d. was found to be much smaller. For Cd it was from 340 to 360 volts, for Zn 285 to 295 volts, and for Mg it was 242 volts. These experiments explain the divergences obtained by previous experimenters and are in excellent accord with the theory of the arc. It is necessary to bring the electrodes to incandescence so that they emit the electrons necessary to maintain the arc. The medium ionised by the shock of these electrons is the most important factor in determining the p.d. When the arcs are long and the current small, therefore, we should expect the p.d. to be the same whatever the metals, provided that the vapour they give off be not large in amount. The authors have also found that for very short arcs taking great currents the p.d. has a minimum potential for a certain pressure of the surrounding medium. Both in nitrogen and in air this minimum value is independent of the kind of metal used for the electrodes. The pressures giving the minimum p.d.'s were from 5 to 7 cm. of Hg. It appears, therefore, that when the rarefaction exceeds a certain amount the number of gaseous molecules between the electrodes is no longer sufficient to allow the necessary ionisation, and so it is necessary to raise the p.d. in order to maintain the current. When the experiments are made on an arc in its most stable state the law connecting the fall of p.d. with the diminution of pressure is rigorously linear. A. R.

1139. *Arc Electrode Potentials.* **M. Toepler.** (Phys. Zeitschr. 9. pp. 872–873, June 1, 1908.)—Discusses the results obtained by Grau and Russ [see Abstracts Nos. 1251 (1907) and 665 (1908)] for the potential across the electrodes of the ordinary and flame arcs. Grau showed that his results for arcs of length l could be expressed by the formula $V = 55 + 12{\cdot}5l + 90l/i$, where V is the potential and i the current strength in amps. The author shows that the results agree very well with the flame arc formula $V = a + bl/\sqrt{i}$, where $a = 55$ and b is about 68. A. W.

1140. *Harmonics in Spark of Self-induction.* **G. A. Hemsalech.** (Comptes Rendus, 146. pp. 1093–1095, May 25, 1908.)—In a previous paper the author gave the results of photographing on a moving film sparks of self-induction, these photographs showing striæ which were attributed to harmonics of the fundamental oscillation [see Abstract No. 1075 (1907)]. This hypothesis was called in question by Battelli and Magri [Abstract No. 1671 (1907)], who attributed the striæ to irregular expulsions of metallic vapour. The author has now repeated his experiments with precautions to exclude such vapour effects, but still obtains the striæ. Moreover, he traces their origin to the inductance in series with the condenser, since they are changed by changes in the value of this inductance. E. H. B.

1141. *Electric Field in the Neighbourhood of Antennæ.* **C. Fischer.** (Deutsch. Phys. Gesell., Verh. 10. 10. pp. 866–870, May 30, 1908. Communication from the Kaiserl. Telegraphenversuchsamt.)—A method of obtaining visible representation of the electric lines of force was previously given by the author (Phys. Zeitschr. 9. pp. 221–222, 1908); in this, crystals of gypsum were strewn on a glass plate upon which strips of tin-foil had been gummed. In the present paper reproductions are given of the pictures obtained when the tin-foil strips are made to represent a two-plate condenser, a Hertz oscillator, an insulated vertical antenna, an umbrella antenna, and a horizontal antenna supported from two masts of a ship in the longitudinal plane. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1142. *Electrical Resistance of Alloys.* **W. Guertler.** (Metallurgie, 5. pp. 292–296, May 22, 1908.)—The existing knowledge of the resistance of alloys is discussed. The main conclusions are that the quest amongst metallic alloys or compounds for a conductor whose conductivity approaches that of copper, silver, or gold is fruitless; that it only appears profitable to study additions to metals and alloys in regard to their improvement of the physical properties without excessive increase of resistance; and that alloys with low temperature-coefficient for resistance purposes are only to be found amongst alloys consisting mainly of one of the high melting-point solid-solution-forming groups (Fe, Ni, Cu, and for special cases Ag, Au, Pt). There is yet a wide field of work with regard to the small additions of metals and metalloids which may usefully be made. F. R.

1143. *Dielectric Constant of Gases at High Pressures.* **K. Tangl.** (Ann. d. Physik, 26. 1. pp. 59–78, May 12, 1908.)—A continuation of a previous research [Abstract No. 1565 (1907)] with improved apparatus. The constants for hydrogen and nitrogen are measured, and that for air remeasured, at 20° between 20 and 100 atmos., and the Clausius-Mossotti relation found to be constant up to 100 atmos. By extrapolation, the dielectric constant, D, at 0° and 1 atmo. is deduced and compared with the square of the refractive index, *n*, for infinitely long waves, viz. :—

Substance.	D.	n.
Hydrogen	1·000273	1·000273
Nitrogen	1·000581	1·000580
Air	1·000576	1·000577

Finally, the dielectric constant, D_m, of a mixture of gases is related to those of the two components, D_1 and D_2, by the formula $D_m = (D_1 - 1) + (D_2 - 1)$.

G. E. A.

1144. *Electrical Conductivity of Solid Substances.* **J. Koenigsberger** and **K. Schilling.** (Phys. Zeitschr. 9. pp. 347–352, May 15, 1908.)—Various solid elements and salts are tested to determine if there is a temperature at which the conductivity is a maximum, and if the conduction is electronic or electrolytic in character. Titanium and zircon show a maximum conductivity at 150° and −80° respectively, and show no polarisation. If the body tested is crystalline in form, the temperature of maximum conductivity varies with the direction of the axis.

R. S. W.

1145. *Emissive Power and Illumination of Crystalline Selenium.* **L. Amaduzzi.** (Accad. Lincei, Atti, 17. pp. 590–593, May 3, 1908.)—E. Hagen and H. Rubens have previously given a relation betweeen emissivity and electrical conductivity for the metals [see Abstract No. 62 (1904)], and the author has endeavoured to find a change in emissivity in crystalline selenium when its electrical conductivity is varied by allowing light to fall upon it. The preparation of the radiating surfaces and the methods of illuminating them and measuring their emissivity are described. The temperature of the radiating surfaces is about 80° C., so that the emissivity for the infra-red rays only is found. The results were negative for several preparations of selenium, no change in the emissivity with variation of intensity of illumination being observable.

S. G. S.

1146. *Thermoelectric Power of Lithium and of Sodium.* **A. Bernini.** (N. Cimento, 15. pp. 29–42, Jan., 1908.)—The thermoelectric power of lithium and of sodium with regard to the standard metal lead, has been measured at different temperatures by means of a Latimer Clark potentiometer. In Avenarius' formula $e = (t_1 - t)[b + a(t_1 + t)]$ the constants for lithium are $b = 0{\cdot}00001281$ and $c = 0{\cdot}00000001905$ between 10° and 173°. The temperature of inversion, *i.e.*, $-b/c$ is equal to $-674{\cdot}21^\circ$; the neutral point is $-332{\cdot}1^\circ$. These results were approximately confirmed by measurements with a Dolezalek electrometer for temperatures between 0° and 173°. For sodium the constants $b = 0{\cdot}000004339$ and $c = 0{\cdot}0000000113$ are valid up to temperatures above the melting-point of sodium; the neutral point is -192°.

D. H. J.

1147. *Resistance Lag of Bismuth.* **P. P. König.** (Ann. d. Physik, 25. 5. pp. 921–982, April 28, 1908.)—A dissertation on the lag of resistance of bismuth in a varying magnetic field, and for varying measuring current. In the first part the resistance is measured statically and dynamically, *i.e.*, in a steady field, and in one increasing suddenly from zero up to the steady value. The instantaneous value of the resistance in the quickly increasing field is measured by means of a Wheatstone bridge, condenser and pendulum interrupter timed by Radakovic's method. The statical and dynamical values are found to lie on the same curve, hence no "viscous hysteresis" of resistance-increase is found to exist. Various corrections are investigated, calculated and applied, giving the result that the rate of change of resistance of the bismuth is 1,228 ohms per sec. Eichhorn's work is criticised in the second part of the paper, and it is concluded that the bismuth spiral should only be used for the measurement of steady fields, since the mean change of resistance in alternating fields does not correspond to the effective value of the field, but depends on the wave-form and on the galvanometer employed.
G. E. A.

1148. *Cadmium Cell at Low Temperature.* **H. Tinsley.** (Electrician, 61. p. 321, June 12, 1908.)—The author has studied the behaviour of cadmium cells containing 10 per cent. and 12½ per cent. cadmium amalgam with a varying temperature. The cell containing 10 per cent. amalgam behaved normally at the lowest temperature dealt with, viz. 3·2° C., and the ordinary temperature correction formula could be applied. The cell containing 12½ per cent. amalgam had a positive coefficient below 15 or 16° C. and at higher temperatures it behaved quite normally, its value varying identically with the 10 per cent. amalgam cell.
F. E. S.

1149. *Electrochemical Equivalent of Oxygen and Hydrogen.* **R. A. Lehfeldt.** (Phil. Mag. 15. pp. 614–627, May, 1908.)—A gas coulombmeter is described which is suitable for the exact measurement of quantities of electricity up to 800 or 1,000 coulombs. The quantity of gas given off was measured in the cases of twelve different solutions of which sodium sulphate and potassium dichromate appear to be the best electrolytes to use in the coulombmeter; no systematic difference could be detected between them, or between solutions of different strengths, or at different temperatures. There is, therefore, every reason to suppose that the electrolysis of these solutions is quantitatively correct. Sodium hydroxide, contrary to what is usually stated, does not seem to yield better results than sulphuric acid. For the calculation of the electrochemical equivalent of oxygen and hydrogen, the value of the current was deduced from a combination of resistances (in international ohms) and a cadmium cell (1·0183 volts at 17° C.). The author concludes that the value of the faraday is 96,590 coulombs, and the electrochemical equivalent of silver is 0·0011174 gm. per coulomb.
F. E. S.

1150. *Comparison of the Board of Trade Ampere Balance with the Ayrton-Jones Current-weigher.* **T. Mather** and **F. E. Smith.** (Roy. Soc., Proc. Ser. A. 80. pp. 383–389, May 25, 1908.)—The Board of Trade ampere balance was set up in 1894. A weight was adjusted so that when a current which deposited silver from a 15 per cent. solution of $AgNO_3$ at the rate of 1·118 mgm. per sec. was reversed, the change in the attraction of the coils in the balance equalled the weight, and this current was taken as the Board of Trade ampere. The authors compare it with the results obtained with the current weigher at the National Physical Laboratory [see Abstract No. 469 (1908)]. The comparison was carried out by the aid of cadmium cells and resistances, the combination giving a secondary standard of current. They conclude that the Board of Trade ampere is equal to the international ampere, as defined by silver deposit, with an inaccuracy of less than one part in 10,000, *i.e.*, within the hundredth part of 1 per cent. They also conclude that current weighers properly designed and constructed are the most satisfactory standards of current. According to their experimental results the Board of Trade ampere will deposit silver at the rate of $1{\cdot}1179_1$ mgm. per sec.—a value which is almost identical with the number $1{\cdot}1179_4$ given by Rayleigh and Mrs. Sidgwick in their classical paper (1884). In an Appendix the values of the e.m.f.'s of standard cells are given as follows. The e.m.f. of the normal Weston cell—

$= 1{\cdot}0187_9$ B. of T. volts at 17° C.
$= 1{\cdot}0186_8$ „ „ 20° C.

The value published by the Reichsanstalt is 1·0186 volts at 20° C. For the normal Clark cell the e.m.f. is given by 1·433 Board of Trade volts at 15° C. This is in good agreement with the number 1·4329 determined directly by A. P. Trotter at the Board of Trade laboratory in 1904. A. R.

1151. *Effect of Self-induction in an Iron Cylinder.* **E. Wilson.** (Roy. Soc., Proc. Ser. A. 80. pp. 369–378, May 5, 1908.)—The "skin-effect" in an iron cylinder 10 in. long and 10 in. in diam. was investigated with currents up to 2,000 amps. of very low frequency, obtained from a direct-current dynamo, by moving the brushes round the commutator by means of a hand-worm and worm-wheel. The instantaneous flux-densities at various depths were measured by means of exploring coils arranged as described in Abstract No. 1778 (1906). Curves and tables are given showing the variation with time of the currents and flux densities at different depths in the cylinder. Experiments were also made at a frequency of about 11 ∾ per sec. The results are not given in a form suitable for being dealt with in an Abstract.

J. D. C.

1152. *Portable Regulating Resistance.* **C. Fredenhagen.** (Zeitschr. Elektrochem. 13. pp. 749–751, Nov. 22, 1907. Electrician, 60. pp. 570–571, Jan. 24, 1908. Abstract.)—The resistance comprises 21 single coils in series, of total resistance 85·25 ohms. They are in 5 groups such that the sum of the resistances of any group is equal to the resistance of a single coil of the preceding group. The coils are as follows: 4 of 16 = 64 ohms; 4 of 4 = 16 ohms; 4 of 1 = 4 ohms; 4 of 0·25 = 1 ohm, and 5 of 0·05 = 0·25 ohm. Diagrams of the arrangements are given. A dial rheostat of the same resistance and degree of adjustment would need 84 separate coils.

L. H. W.

1153. *Apparatus for Measurement of Short Exposures and for producing Single Sparks.* **F. H. Glew.** (Röntgen Soc., Journ. 4. pp. 71–72 and 73; Discussion, pp. 73–74, May, 1908.)—An inclined plane with a horizontal portion, both provided with insulated metal rails is used. For measuring short Röntgen exposures a steel ball is caused to roll on the rails down the inclined portion. A portion of one or both rails is covered with a paper strip and sparks are allowed to pass from the coil through the circuit formed by the rails and ball, thus making a tape record of the number of sparks per sec., calculable from the velocity of the ball. In the second article an application of the method to closing and opening a circuit so as to give a single spark is described. L. H. W.

ALTERNATING CURRENTS AND MAGNETISM.

1154. *Alternate-current Measurement.* **W. E. Sumpner.** (Roy. Soc., Proc. Ser. A. 80. pp. 310–352, May 5, 1908.)—The paper is divided into four parts. In the first the mathematical relationships of cyclic quantities are considered. In the second part the action of a cyclic magnetic field on a movable coil conveying a current of the same frequency is discussed. In the third part the theory of shunt-magnet instruments is considered, and in the fourth part the author experimentally verifies his theory and describes a novel type of compensated wattmeter. He also points out that by utilising the properties of separately excited fields controlled by the supply voltage it is possible to construct alternating-current voltmeters the deflecting force in which is proportional to the first power of the voltage. Hence the null methods which are always employed in direct-current measurements when high accuracy is desired can be extended to alternating-current measurements. A. R.

1155. *Magnetic Behaviour of Pure Iron.* **H. Kreusler.** (Deutsch. Phys. Gesell., Verh. 10. 9. pp. 344–350, May 15, 1908.)—Very pure iron was prepared from recrystallised ammonium iron sulphate, special care being exercised to eliminate sulphur. The iron so obtained being of spongy nature, was rendered homogeneous by fusion *in vacuo.* For this purpose the spongy iron was formed into rods by hydraulically pressing it into hard glass tubes, whilst it was at the same time electrically heated. Drops of molten iron were then obtained by forming an arc between these rods *in vacuo* over mercury. Finally the resulting globules were rolled into small strips or wires. Preliminary tests showed that the hysteresis loss of such iron is greater than that of the best armature stampings, and that its specific resistance is 9·4 microhms/cm.^{3} at 0° C., and its mean temperature-coefficient (between 0°—100° C.), 0·0055. The paper is mainly devoted to the chemical preparation of very pure iron. J. D. C.

1156. *Magnetic Properties of Pure Iron.* **E. Gumlich.** (Deutsch. Phys. Gesell., Verh. 10. 10. pp. 371–376, May 30, 1908.)—Ballistic tests of the magnetic qualities of a small specimen of very pure iron prepared by H. Kreusler [see preceding Abstract] are described. Owing to the smallness of the specimen, which consisted of a small round wire, 14·65 cm. long by about 0·0904 mm. diam., weighing 7·424 mgm., the principle of the magnetic balance was made use of. Two similar cylindric magnetising solenoids, 70 cm. long, were connected in series and to a battery and rheostat. In one was placed the search coil to receive the specimen, in the other a double search coil having a variable mutual induction relatively to its magnetising solenoid. These search coils were connected in opposition and to a ballistic galvanometer, and by adjustment of the latter coil balance could be obtained for all magnetising currents. With the specimen inserted the balance was disturbed, and from the deflections obtained the flux density was calculated. The specimen and its search coil were kept at uniform temperature by a cylindrical water-jacket separating them from the magnetising coil. The smallness of the specimen necessitated corrections for the error due to the comparatively large size of the search coil. A table is given comparing the magnetic qualities of the specimen with those of a similar specimen of good dynamo sheet-steel. This is summarised as follows: *Pure Iron.*—Coercive force, 2·6; remanence, 12,250; max. μ, 2,260; hysteresis loss in ergs per cm.^{3} per cycle (at $B = 17{,}370$, $H = 138$) $= 20{,}100$. *Dynamo Sheet Steel.*—Coercive force, 0·4; remanence, 11,050; max. $\mu = 4{,}200$; hysteresis loss in ergs per cm.^{3} per cycle (at $B = 18{,}930$, $H = 138$) $= 3{,}760$. *Analysis of Dynamo Sheet Steel.*—Mn. 0·4; C, 0·04; P, 0·04; S, 0·03; Cu, 0·13 per cent. The author suggests that the relatively bad magnetic properties of the pure iron specimen may be due to the presence of hydrogen, and to the high temperature (1,400° C.) at which it was incandesced to get rid of the hydrogen. J. D. C.

1157. *Vertical Component of Terrestrial Magnetism on Mountains.* **B. Brunhes** and **P. David.** (Comptes Rendus, 146. pp. 878–880, April 21, 1908.)—Measurements made on the Puy de Dôme and on several neighbouring peaks show that the vertical component increases with increasing altitude; the increase is proportional to the altitude, and becomes stronger still on level surfaces. When the altitude increased from 1,009 to 1,410 m. the vertical component rose from 0·3833 to 0·4320. H. B.

1158. *Diurnal Variation of Terrestrial Magnetism.* **A. Schuster.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 163–204, April 22, 1908. Proc., Ser. A. 80. pp. 80–82, Dec. 9, 1907. Abstract.)—It is taken as satisfactorily proved that the diurnal variation of terrestrial magnetism has its origin outside the earth's surface, caused by the electric currents circulating in the upper regions of the atmosphere. On examining this analytically, treating the diurnal and semidiurnal variations separately, the calculation leads to the interesting results that each of them is caused by an oscillation of the atmosphere which is of the same nature as that which causes the diurnal changes of barometric pressures. C. P. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

1159. *Law of Distribution of Rays from a Röntgen Tube.* **H. Bordier.** (Archives d'Él. Médicale, 16. pp. 299–304, April 25, 1908.)—The author finds, by platinocyanide exposures, that the falling-off in radiochromometric effect of the emission from the antikathode as the angle made with the position of maximum emission increases from 0° to 90°, is expressible by the cosine law for the case where this emission is measured in the plane (symmetrical) including the line: kathode–antikathode. For the plane at right angles to this (*i.e.*, 90° displaced on the great circle of the bulb) the falling-off is much slower; experiments show that the intensity diagram is in this case an ellipse. L. H. W.

REFERENCES.

1160. *Registering of Atmospheric Potential.* **K. Kähler.** (Meteorolog. Zeitschr. 25. pp. 155–162, April, 1908. Phys. Zeitschr. 9. pp. 258–260, April 15, 1908. Communicated from the Meteorolog.-Magnetischen Observatorium, Potsdam.)—Describes results of measurements of the atmospheric potential-fall at two neighbouring stations. The fall was measured by means of a Benndorf quadrant electrometer, which mechanically registered the value of the potential each minute. The effect of wind and rain is dealt with. A. W.

1161. *Use of Undamped Waves in Damping Measurements.* **H. R. v. Traubenberg** and **B. Monasch.** (Phys. Zeitschr. 8. pp. 925-927, Dec. 15, 1907.)—The author points out that they have been able to make very satisfactory measurements of small dampings by using an arc arrangement which is stated to have given oscillations of a very constant wave-length, and a very loose coupling. The method is described. **R. H. Rendahl.** (Ibid. 9. pp. 135-136, Feb. 15, 1908.)—Rendahl criticises the arrangement. **H. R. v. Traubenberg.** (Ibid. pp. 251-253, April 15, 1908.)—A reply to Rendahl's criticism. L. H. W.

1162. *Quadrant Electrometer.* **H. Schultze.** (Zeitschr. Instrumentenk. 28. pp. 61-69, March, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—Discusses at length a difficulty met with in the use of the sensitive quadrant electrometer previously described. [See Abstract No. 1192 (1907); also No. 1282 (1906).] A. W.

1163. *Theory of Electrocapillarity.* **Gouy.** (Comptes Rendus, 146. pp. 612-615, March 23, 1908.)—A general exposition of the author's view that, in considering the case of a metal immersed in an electrolyte, we should take into account, not only the electric forces, but also *the non-electric forces* that may be exerted at short range between the metal and the ions or between the metal and the dissolved molecules and between the metal and the molecules of the solvent. D. H. J.

1164. *Compensation of an Electromagnetic Compass for Conning-towers and Submarines.* **L. Dunoyer.** (Comptes Rendus, 145. pp. 1142-1144, Dec. 9, and pp. 1323-1325, Dec. 23, 1907.)—This compass can be compensated in a few minutes. The Kelvin compass requires at least a day. The importance of this in warfare, where the magnetism of the ship may be changed by the impacts to which it is subjected, is pointed out. A. R.

1165. *Low-resistance Potentiometer.* **H. Diesselhorst.** (Zeitschr. Instrumentenk. 28. pp. 1-13, Jan., 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—A description of a new 5-dial low-resistance potentiometer, free from thermal e.m.f., made by O. Wolff for the Reichsanstalt. An exhaustive description of the principle and the construction is given, and the method of calibrating, together with the limits of its usefulness, are fully discussed. The original paper should be seen by those interested. F. E. S.

1166. *New Universal Variometer.* **E. Mayer.** (Ann. d. Physik, 25. 4. pp. 783-806, March 31, 1908. Tübinger Inaug.-Dissertation, 1907.)—Description of a new instrument for determining local variations of horizontal intensity and declination. C. P. B.

1167. *Variations of Magnetic Declination at Kew,* 1890-1900. **C. Chree.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 205-246, May 19, 1908. Proc., Ser. A. 80. p. 113, Feb. 13, 1908. Abstract. From the National Physical Laboratory.)—In previous papers the author has shown that various phenomena presented by the discussion of "quiet day" magnetograms at Kew from 1890-1900 are equally prominent in the similar records at Falmouth. In the present paper he investigates the whole of the Kew data in relation to diurnal inequality, absolute range, frequency of occurrence of maxima and minima at different hours of the day, annual variations, relation to sun-spot activity, the various relationships being shown in tabular form. C. P. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1168. *Atomic Weight of Hydrogen.* **W. A. Noyes.** (Bureau of Standards, Bull. 4. pp. 179–204, Jan., 1908. Amer. Chem. Soc., Journ. 29. pp. 1718–1739, Dec., 1907. Chem. News, 97. pp. 56–58, Jan. 31; 64–67, Feb. 7, and pp. 76–79 Feb. 14, 1908.)—From the results of four separate series of careful experiments, in which hydrogen and oxygen from various sources were combined, the author arrives at the mean value, 1·00787 ($O = 16$), for the atomic weight, of hydrogen. The most trustworthy value is considered to be 1·00775, the mean between the above number and the value, 1·00762 ± 0·00002, obtained by Morley. During the experiments the author sought to obtain evidence with regard to the question of change of weight occurring in chemical reactions in which a large amount of energy is dissipated. No conclusive evidence was obtained, but any change of weight which may occur must be very small. T. H. P.

1169. *Atomic Weight of Chlorine.* **W. A. Noyes** and **H. C. P. Weber.** (Bureau of Standards, Bull. 4. pp. 345–364, Jan., 1908. Amer. Chem. Soc., Journ. 30. pp. 13–29, Jan., 1908.)—The authors give the results of a series of determinations of the proportions in which hydrogen and chlorine combine to form HCl. The hydrogen was weighed absorbed in Pd, and the chlorine in the form of potassium platinichloride; the hydrogen was passed over the heated platinichloride, the resulting HCl being condensed and weighed. The average value obtained for the atomic weight of chlorine is 35·184 ± 0·0008 ($H = 1$). T. H. P.

1170. *Molecular Attraction.* VII. *Examination of Seven Esters.* **J. E. Mills.** (Journ. Phys. Chem. 11. pp. 594–622, Nov., 1907.)—The author has applied the equation, $(L - E_1)/(\sqrt[3]{d} - \sqrt[3]{D}) =$ constant, to seven esters not previously studied. [Compare Abstract No. 1219 (1907).] The results indicate the validity of the equation, and the author therefore concludes that the assumption on which this equation is based, namely, that the molecular force varies inversely as the square of the distance from the attracting particle, is a true one. Further examination of Crompton's formulæ, $L = 2RT \log_e (d/D)$, confirms the conclusion that this relation gives results for the heat of vaporisation uniformly too high at low vapour pressures, but that, at high vapour pressures, in the neighbourhood of the critical temperature, the equation is accurate. Certain relations which hold at the critical temperature, and which have been already discussed (*loc. cit.*) are confirmed for the seven esters examined. T. H. P.

1171. *The Electron as an Element.* **W. Ramsay.** (Chem. Soc., Journ. 93. pp. 774–788, April, 1908. Presidential Address, delivered March 26, 1908.)—The following hypothesis is tentatively put forward: "Electrons are atoms of the chemical element, electricity; they possess mass; they form compounds with other elements; they are known in the free state, that is, as molecules; they serve as the 'bonds of union' between atom and atom. The electron may be assigned the symbol E." If this is done, neutral atoms of ordinary elements must be regarded as "electrides" or compounds of the elements with the element electricity. The action of HCl on silver nitrate is then represented by the following equation :—

$$H(ECl).Aq + Ag(ENO_3).Aq = AgECl + H(ENO_3).Aq.$$

A simple case of oxidation would be the following :—

$$2EFe(ECl)_2.Aq + Cl_2.Aq = 2Fe(ECl)_3.Aq\,;$$

greater trouble is encountered when the bodies are not ionised, or only partly ionised, such as perchloric acid. Its formula $HClO_4$ may be written—

$$HEO(E_4)ECl[E_2O(E_4)]_3.$$

The first $(E)_4$ means that the oxygen is normally associated with four electrons besides the two which it receives from the hydrogen and the Cl ; the second $(E)_4$ implies that each oxygen atom is associated with four electrons besides the two which it takes from the Cl. In Abegg's phraseology, oxygen possesses two normal valencies which are here latent, and four contravalencies which here become operative. A plus sign in Abegg's scheme may be taken to signify ability to part with one or more electrons, whilst a minus sign is the ability to receive one or more electrons. The author also suggests lines of possible explanations of the extrusion of ionisable groups in such compounds as the cobaltammine nitrites by further addition of ammonia, and the directive influence of the presence of certain substitutive elements or groups on the position into which further substituents enter. E. E. F.

1172. *Influence of Radium on the Decomposition of Hydriodic Acid.* **H. J. M. Creighton** and **A. S. Mackenzie.** (Amer. Chem. Journ. 39. pp. 474–498, April, 1908.)—The authors find that, when prepared with very pure water, hydriodic acid solution decomposes in the dark, reaching a condition of equilibrium. Ordinary distilled water contains impurities producing some catalytic action which accelerates the decomposition in the dark, at the same time introducing another reaction which causes the amount of free iodine to reach a maximum value and then fall off immediately. At any temperature up to 24°, the amount of iodine liberated in any given time from a solution of hydriodic acid in the dark is increased under the influence of radium; at 86° this is only true up to 22 hours, for, whereas the amount of free iodine with no radium reaches an equilibrium value, with radium it attains a maximum and then falls off indefinitely. The amount of free iodine at any time depends on three quantities: an accelerating factor depending on the rate at which hydrogen iodide decomposes into hydrogen and iodine, and two retarding factors, the one depending on the rate at which hydrogen and iodine recombine, and the other on the rate at which hydrogen iodide enters into another reaction. One of these two retarding factors is inappreciable at temperatures as low as 24°. The γ-rays alone cause more iodine to be set free than the β- and γ-rays together, probably owing to the β-rays increasing the retarding factors more than the γ-rays. Neither sunlight nor radium causes decomposition of hydriodic acid solution at ordinary temperatures in the absence of oxygen. T. H. P.

1173. *Compressibility of the Elements.* **T. W. Richards.** (Zeitschr. Elektrochem. 13. pp. 519–520 ; Discussion, p. 520, Aug. 9, 1907. Paper read before the 14 Hauptversamml. d. Deutsch. Bunsen-Gesell., Hamburg, May 12, 1907.)—In measuring the compressibility of the elements, the author makes use of a glass vessel of suitable shape provided with a narrow limb into which the end of a Pt wire projects. The vessel is first filled with mercury, and the change of volume for different pressures measured by placing the whole vessel under the liquid in Cailletet's pressure apparatus, and after adding different weighed amounts of mercury, determining the various pressures at which the mercury in the narrow limb comes into electrical contact with the Pt wire. The substance to be examined is afterwards introduced, together with mercury, into the vessel, and a fresh series of measurements made. The compressibility of the substance is thus obtained in terms of that of mercury. The values obtained for 35 elements show that the compressibility of the elements is a periodic function of the atomic weight, the curve obtained closely resembling the atomic volume curve. [See next Abstract.] T. H. P.

1174. *Compressibility of the Elements and their Periodic Relations.* **T. W. Richards, W. N. Stull, F. N. Brink,** and **F. Bonnet, Jr.** (Zeitschr. Phys. Chem. 61. pp. 171–199, Nov. 26, 1907. From the English.)—The cubical compressibilities of iron and copper relatively to that of mercury and the linear compressibilities of iron and copper were determined. From these values the cubical compressibility of mercury was calculated. The compressibilities of a number of other elements were then determined with respect to mercury. The following table gives the compressibilities, in megabars × 10^6, between 100 and 500 atmos. pressure:—

Magnesium ...	2·7	Palladium......	0·38	Manganese...	0·67
Calcium	5·5	Platinum	0·21	Nickel.........	0·27
Zinc	1·5	Tin................	1·7	Chromium ...	0·7
Cadmium......	1·9	Lead	2·2	Molybdenum	0·26
Copper	0·54	Thallium	2·6	Arsenic	4·3
Silver	0·84	Aluminium ...	1·30	Antimony ...	2·2
Gold	0·74	Iron	0·40	Bismuth	2·8

Comparison of these numbers with those previously obtained for other elements [see Abstract No. 1595 (1907)] shows that compressibility is a periodic property of the elements, and that it probably depends, to some extent, on the causes which determine the atomic volume and volatility. The compressibilities of the alkali metals are dealt with elsewhere (Ibid. pp. 77–99, Oct. 29, 1907). T. H. P.

1175. *Heats of Solution of Alkali Metals and Heats of Formation of their Oxides.* **E. Rengade.** (Comptes Rendus, 146. pp. 129–131, Jan. 20, 1908.)—Using a bomb calorimeter nearly filled with water and fitted with a stuffing-box through which passes a steel rod for crushing an evacuated flask containing the alkali metal, the author obtains the following thermal constants: Na, Aq = 44·1; K, Aq = 46·4; Rb, Aq = 47·25; Cs, Aq = 48·45. Na_2O, Aq = 56·5; K_2O, Aq = 75·0; Rb_2O, Aq = 80·0; Cs_2O, Aq = 83·2. From these two series of values, the heats of oxidation of the metals are calculated to be: Na_2, O = 100·7; K_2, O = 86·8; Rb_2, O = 83·5; Cs_2, O = 82·7. T. H. P.

1176. *Density of Fused Salts.* **R. Lorenz, H. Frei,** and **A. Jabs.** (Zeitschr. Phys. Chem. 61. pp. 468–474, Jan. 21, 1908. Lab. f. physikal. Chemie u. Elektrochemie am eidg. Polytechnikum, Zürich, 1905–1907.)—The densities were determined by weighing a small Pt sinker in the fused salt, the latter being maintained at constant temperature in an electric furnace. The following results were obtained :—

$KNO_3 = 2{\cdot}044 - 0{\cdot}0006t$ (348° to 492° : m.p. 329°).
$NaNO_3 = 2{\cdot}12 - 0{\cdot}0007t$ (320° to 515° : m.p. 310°).
$PbCl_2 = 5{\cdot}627 - 0{\cdot}00144t$ (522° to 740° : m.p. 512°).
$PbBr_2 = 6{\cdot}175 - 0{\cdot}00145t$ (600° to 800°).
$CdCl_2 = 3{\cdot}731 - 0{\cdot}000685t$ (600° to 800°).
$KBr = 2{\cdot}626 - 0{\cdot}00081t$ (600° to 800°).
$$\left.\begin{array}{l} NaCl = 1{\cdot}986 - 0{\cdot}00054t \\ KCl = 1{\cdot}968 - 0{\cdot}00057t \\ NaBr = 2{\cdot}9825 - 0{\cdot}0008t \\ LiCl_2 = 1{\cdot}762 - 0{\cdot}00042t \end{array}\right\} \text{Recalculated from data by Tammann and Brunner.}$$

Values are also given for mixtures of lead chloride with potassium and barium chlorides, lead bromide with potassium bromide, and cadmium chloride with potassium chloride. T. M. L.

1177. *Transformation of dissolved Yellow Phosphorus into Red Phosphorus.* **A. Colson.** (Comptes Rendus, 146. pp. 71–73, Jan. 13, 1908.)—The author's experiments lead to the conclusion that the only effect of the presence of a solvent upon this transformation is to retard its commencement, the more the greater the dilution of the solution. In all cases the deposited red phosphorus was amorphous, and there appeared to be no reaction between phosphorus and terebenthene at 260°. F. R.

1178. *Granular Carbon Resistors.* **S. A. Tucker, A. Doty,** and **R. W. Cauchois.** (Amer. Electrochem. Soc., Trans. 12. pp. 171–190 ; Discussion, p. 190, 1907.)—In the use of granular carbon for resistance material in the electric furnace, many varying conditions may exist dependent on the size of carbon grain, the compression to which the grains have been subjected and the number of times the material has been used. The material used for the investigation of the above points was ordinary gas coke, which was ground and graded in sieves of 10, 20, 30, 40, and 50 meshes to the inch. Using green coke unsatisfactory results were obtained, for, as the temperature rose, the resistance varied rapidly, due to the evolution of the volatile matter in the coke. In the grading tests, coke from which the volatile matter had been previously driven off was used, and, with a variable direct current, grade 30 was most efficient, 870° being reached, using 72 watt-hours, as against 181 for grade 50 and 108 for grade 10. A mixture of all grades required 207 to reach the same temperature. From experiments on the effect of reheating the coke it was found that twice-heated coke is more efficient than once-heated, and there is reason to suppose that green coke is still better. From tests made under a pressure of 10 lbs., the results indicated that this pressure caused a considerable decrease in the resistance. From a consideration of the results obtained, it is left an open question as to whether a resistor material of high or low resistance is most efficient. The tests using alternating currents seem to indicate that a greater efficiency is obtainable with this than with direct current. The coarser the grade of coke the greater is its conductivity. C. O. B.

1179. *Silicon Monoxide* (*Monox*). **H. N. Potter.** (Amer. Electrochem. Soc., Trans. 12. pp. 191–213 ; Discussion, pp. 213–214, 215–222, and pp. 223–

228, 1907. Elect. Engineering, 2. p. 878, Dec. 5, 1907. Abstract.)—C. Winkler could not obtain SiO by heating $SiO_2 + Si$ up to about 1,000° C., but in the electric furnace at 1,700 or 1,800° C. the monoxide appears to be produced. Although some silicon carbide is formed (from the Acheson graphite electrodes) the chief reaction is not due to the carbon. Analyses do not decide whether or not the brown smoke and powder obtained, which burns to SiO_2, is SiO or a mixture of SiO_2 and Si. Calorimeter tests, made with the author's bomb calorimeter, show, however, that while mixtures of Si and SiO_2 give only as much heat as the Si (as was to be expected) the brown oxide yields from 200 to 800 cal./gm. more than any form of silicon, which, the author assumes, occurs in several modifications. The specific heat determinations of the brown powder varied between 0·188 and 0·209, the densities ranged from 2·19 to 2·24. Cooling on the furnace walls, the brown powder dissociates into a vitreous mixture of Si and SiO_2; this vitreous oxide is sometimes purple, and in that case globules of crystalline silicon can be distinguished in it under the microscope. Treated with HF, the brown powder becomes richer in Si; freshly prepared, it decomposes water, which silicon itself also does, soon covering itself with a protecting film of SiO_2; this film can be dissolved off with HF. The commercial monox is described in the second paper as an extremely fine, silky-feeling, opaque powder of light-brown colour—a mixture probably of SiO, Si, SiO_2 with some silicon carbide and metallic impurity. It is exceedingly voluminous; freshly prepared it can be burned in the air, burning slowly without flame; after standing it will burn in oxygen. It is soluble in caustic alkalies under liberation of hydrogen and production of silicates; HF attacks it; when nitric acid is further added complete dissolution results. When the HF contains fluorides of Hg, Ag, Cu, these compounds are at once reduced by nascent hydrogen on adding some monox. Dry monox becomes powerfully electronegative when drawn through a rubber tube, and adheres then to cotton-wool; in this way gases can be filtered of monox particles. A little monox thickens oil very considerably, and owing to this high oil ratio it makes an excellent anti-rust paint for iron. It is also recommended for "laying" printing inks. A mixture of oil of monox becomes thicker when hot and is in so far a suitable lubricant. The third paper describes the manufacture of monox (from glass-maker's sand, coke, graphite, silicon carbide, and silicon or siloxicon or carborundum fire-sand) in an arc-furnace whose throat discharges directly into a large container free from air, a partly exhausted boiler-plate cylinder. The current is supplied by a rotating field alternator designed by Tingley, of the Westinghouse Electric Co., for operating a single arc near the top of the volt-ampere characteristic; the generator is separately excited, and the circuit can be broken or dead short-circuited without risk. A. S. Albro, A. B. Albro, E. M. Sewett, J. M. Finch, H. Siegel, and further F. S. Hyde, J. M. Fitzgerald, A. Cochard, and E. Ward have assisted in the researches. As to the patents, compare Abstract No. 871B (1908). H. B.

1180. *Rare Metals.* Part I. *Molybdenum.* **G. Gin.** (Amer. Electrochem. Soc., Trans. 12. pp. 411–474, 1907. Translation.)—This memoir contains a detailed account of molybdenum, giving the ores and modes of occurrence; methods of concentration and purification of the ores, including mechanical concentration, separation by sieving, electrostatic and flotation methods, and chemical purification of the concentrates obtained. Methods of manufacture of molybdic anhydride and other compounds are then given, followed by the methods used for the preparation of pure Mo, including a full account of the electrolytic manufacture from the double chloride of Mo and Na, which produces the metal free from carbon. The e.m.f. used is 9–10 volts, varying with the concentration of Mo in the bath; the current density should be between 1 and 1·5 amps. per cm.^{2} of horizontal section of the anodes. The superficial current density should not be above 0·8 amp./cm.^{2}. This electrolysis of the double chloride has two disadvantages, viz., (1) the bath is impoverished as the metal is liberated, making a variation in its running and a discontinuity of the operation; (2) the chlorine disengaged rapidly attacks the carbon electrodes and exposed parts of the apparatus. These difficulties may be overcome by adding at regular intervals a quantity of molybdenum chloride, and by substituting anodes made of cast Mo for the carbon anodes, the cast anodes being obtained by a simple reduction of molybdic dioxide by carbon; this then practically becomes a method of refining the crude metal. The Mo obtained by this process is not in a melted state, but is a porous deposit, which may be melted down in an electric furnace. "Cast" Mo may be made in a resistance furnace similar to that used for calcium carbide manufacture, a charge being composed of MoO_2 and carbon; this "cast" metal is very fluid, casts easily, and gives in the air vivid sparks and thick fumes of molybdic acid. "Cast" Mo may be refined by heating in contact with MoO_2 either in a furnace with "flowing" electrodes or in an induction furnace (full details of which are given). The manufacture of molybdenum silicide, ferro-molybdenum, nickel molybdenum, and chrome-molybdenum are next given together with an account of the action of Mo on steels; here it is stated that Mo largely increases the ductility and elasticity of hard steels. Mo alloyed with Ni is useful for rifle and cannon steels and for boiler-plates for high pressures. Rapid-cutting tool steels contain 0·5–10 per cent. Mo. The memoir concludes with methods of detection and analysis of the metal and a table of several alloys of Mo. C. O. B.

1181. *The Systems: Platinum-Arsenic and Bismuth-Arsenic.* **K. Friedrich** and **A. Leroux.** (Metallurgie, 5. pp. 148–149, March 8, 1908. Communication from the Metallograph. and Metallurg. Laborat. d. kgl. Bergakademie, Freiberg.)—*System: Platinum-Arsenic.*—The possible existence of the compound Pt_2As_3 is indicated, solidifying at about 1,450° C. There is a eutectic solidifying at about 597°, but extending over a range of about 30° even when inoculated. It is not established whether the compound occurs in the samples between the eutectic composition, 13 per cent. As, and higher As-content. The lowness of the eutectic temperature explains the weakness of Pt in presence of As vapour. There appear to be no solid solutions of As in Pt. *System: Bismuth-Arsenic.*—The diagram consists of two horizontal lines, one at the solidification temperature of pure Bi (267°), the other from about 3 per cent. As, between 480° and 490°. No other line could be observed, and it appears probable that there is no solid solution whatever. F. R.

1182. *Alloys of Manganese with Copper and Nickel.* **S. Żemcżużny, G. Urasow,** and **A. Rykowskow.** (Zeitschr. Anorg. Chem. 57. 3. pp. 253–266, March 4, 1908. Translated from Ann. d. St. Petersbourg Polyt. Inst. 8. 29, 1907.)—The Mn-Cu and Mn-Ni alloys form continuous series of solid solutions, the solidification curve in each case being a continuous line with a minimum at 868° C. and 33 atoms per cent. Mn in the Cu-Mn series, and at 1,030° C. and 56 atoms per cent. Mn in the Mn-Ni series. All the alloys, except those corresponding to the minima, possess ranges of solidification, and their microstructures show that they consist of heterogeneous solid solutions. The alloys corresponding to the minima solidify at constant temperatures, and consequently possess homogeneous structures. It is interesting to note that the electrical conductivity curve of the Mn-Cu alloys shows a minimum at about 80 atoms per cent. Mn. The authors consider that the discrepancies between their results and those obtained by Wologdine in the Cu-Mn series are due to the carburisation of the latter's alloys, brought about by fusion under charcoal. F. C. A. H. L.

1183. *Copper-Tin Alloys.* **O. Sackur** and **H. Pick.** (Zeitschr. Anorg. Chem. 58. 1. pp. 46–58, May 1, 1908. Chem. Inst. d. Univ., Breslau.)—The authors attempt to obtain a quantitative measure of the chemical affinities existing between these metals in their alloys by a method depending upon the fact that a free constituent of the alloy behaves like the pure metal in precipitating a more electro-positive metal from solution; the same conditions of equilibrium being obtained in both cases. If, however, solid solutions or chemical compounds are formed, the conditions of equilibrium are disturbed. Powdered copper-tin alloys were treated with saturated solutions of lead chloride, cuprous iodide, bromide and chloride, and cupric chloride and sulphate. The experiments showed that alloys containing less than 57 per cent. Cu precipitate lead to the same equilibrium conditions as are obtained with pure tin, showing the presence of free tin in these alloys. Between 57 and 60 per cent. Cu the alloys do not precipitate Pb from solutions, nor Cu from cuprous oxide, but will precipitate Cu from cuprous bromide and chloride. Hence the solution tension of the tin in the copper-tin compound lies between the potential required to precipitate Cu from cuprous iodide and that necessary to precipitate Cu from cuprous bromide. Alloys containing over 60 per cent. Cu will not precipitate Cu from cuprous salts, but will decompose cupric salts. The experiments point to the existence of two compounds: Cu_3Sn, and Cu_5Sn_3 or Cu_3Sn. F. C. A. H. L.

1184. *Thermomagnetic Analysis of Meteoric and Artificial Nickel-Iron Alloys.* **S. W. J. Smith.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 21–109, March 18, 1908. Proc., Ser. A. 79. pp. 132–133, April 24, 1907. Abstract.)—A theory is developed in detail that taenite, the nickel-rich constituent of meteoric iron, occurs as a mixture of a 6 and a 40 per cent. nickel alloy. Repeated heating reduces the coarseness of the mixture until ultimately it becomes the eutectoid containing about 27 per cent. Ni, whose existence was suggested by Roozeboom and by Osmond. The theory agrees closely with the variations of permeability observed in a sample of the Sacramento meteorite (Ni 6·81 to 7·86 per cent., Fe 91·39 to 93 per cent.) throughout the course of repeated heatings. The other constituent of meteoric iron, kamacite, is a solid solution of 6 per cent. Ni in Fe. The usual structure is developed, it is suggested, during exceedingly slow cooling at temperatures from 600° C. downwards. Results of magnetic measurements on a nickel steel of about the same composition are given; and it is shown that published data obtained from artificial Ni-Fe alloys agree with the views of the constitution given. In the artificial alloys the diffusion has proceeded sufficiently for the existence of the 27 per cent. eutectoid. The eutectoid structure is not confirmed by the microscope, but evidence of a "sorbitic" structure in taenite is given. F. R.

1185. *Iron-Vanadium Alloys.* **R. Vogel** and **G. Tammann.** (Zeitschr. Anorg. Chem. 58. 1. pp. 73–82, May 6, 1908. Communication from the Inst.

f. physikal. Chemie d. Univ., Göttingen.)—A series of alloys made in crucibles contained from 6 to 8 per cent. Si. Hence a temperature-concentration diagram for this series is given. Alloys with more than 80 per cent. V were made by aluminothermic reduction of mixtures of Fe_2O_3 and V_2O_5. The series in which Si was practically absent consists entirely of mixed crystals. A minimum occurs in the curve of commencement of solidification at 82 per cent. V (1,435°), and the curves of completion of solidification lie considerably lower except at this point and the ends. In the 6–8 per cent. Si series the minimum occurs at 1,339° ; miscibility is not complete between 55 and 90 per cent. V, and it is possible that alloys between these compositions consist of a mixture of two solid solutions, containing 55 and 90 per cent. V respectively. The significance of the changes occurring at temperatures below solidification is doubtful. F. R.

1186. *Action of Calcium and Calcium Hydride on Oxides, Sulphides, and Chlorides.* **F. M. Perkin** and **L. Pratt.** (Faraday Soc., Trans. 3. pp. 179–185 ; Discussion, p. 186, March, 1908.)—Calcium hydride is used successfully for reduction in some cases, although not so energetic an agent as pure calcium, because its heat of formation from Ca and H is considerable. Finely-divided copper, manganese, iron, tungsten, and boron, and a button of lead or of tin were obtained from the respective oxides, and with zinc oxide no reaction ; silica gave a small yield of silicon. Lead and antimony sulphides gave small yields of Pb and Sb ; it is probable that double sulphides of Pb and Sb were formed. The reduction of tungsten and titanium oxides and of the alkaline hydroxides by metallic calcium was satisfactory. Metallic calcium reacted with alumina, but no globules of metal were formed. The reaction with strontium, barium, and calcium oxides was probably the production of lower oxides. The chlorides of Ba, Sr, Pb, Al, and the alkaline metals were reduced, and an alloy of the respective metals with calcium formed. The temperature was sufficient to volatilise the alkaline metals off however, and in the case of Al it is probable that a mixed or double chloride was formed. Ca and CaH_2 react with sulphur, phosphorus and selenium. F. R.

1187. *The System: Cobalt-Arsenic.* **K. Friedrich.** (Metallurgie, 5. pp. 150–157, March 8, 1908. Communication from the Metallograph. and Metallurg. Laborat. d. Kgl. Bergakademie, Freiberg.)—Gives the equilibrium diagram for alloys containing up to 58·5 per cent. As. The existence of the compounds Co_5As_2, Co_2As, and Co_3As_2 is established, and that of CoAs is possible. Each of the three first named has a transformation-point at temperatures 828°, 352°, and 915° C. respectively. The separation or formation of the β forms of these commences at 1,014°, 959°, and 926° C. respectively. No micrographic difference between the α and β forms was detected, but the change from β Co_2As into the α form is accompanied by a great increase of volume. Mixed crystals Co — As may contain up to 1 per cent. As. These form a eutectic with β Co_5As_2, containing about 30 per cent. As, and solidifying at 916°. Specimens containing up to 38 per cent. As are magnetic. Co_2As is non-magnetic. Photomicrographs are given. F. R.

1188. *Platinum-Thallium Alloys.* **L. Hackspill.** (Comptes Rendus, 146. pp. 820–822, April 13, 1908.)—Crystals of free PtTl are left when alloys of Pt and Tl containing up to 10 per cent. Pt are treated with 1 in 10 nitric acid. The melting-point of this compound is 685°, density 15·65, hardness

(Mohs scale) 8, specific heat 0·0450. This compound is analogous to PtPb. There is a minimum solidification temperature between 0 and 48·8 per cent. Pt. F. R.

1189. *Corrosion of Iron.* **E. Heyn** and **O. Bauer.** (Königl. Materialprüfungsamt, Mitt. 26. 1 and 2. pp. 1–104, 1908.)—It is found that the presence of CO_2 is not essential in order that rusting of iron may take place. Apart from the influence of CO_2, the rate of rusting increases with the partial pressure of oxygen in the atmosphere over the water in which the sample is placed. These results refer to distilled water, Charlottenburg water, and artificial sea-water. The addition of charcoal to water in which iron is immersed substantially diminishes the rate of rusting. The effect of varying concentration in oxygen and of proportion of liquid to surface of specimen was investigated. The addition of H_2O_2 to the water had no greater effect on rate of corrosion than leading air through the water. No argument for or against the hydrogen-peroxide theory of rusting was, however, deducible from the results. The rate of rusting of iron in water under coal-gas atmosphere was only half the rate under air. With copper in contact with the iron the rate of corrosion in Charlottenburg tap-water was increased 25 per cent., and in sea-water 47 per cent. Check experiments showed that this difference was not due to the decomposition of the water *per se*. Contact with nickel increased the rate of corrosion from 14 to 19 per cent. In contact with cast iron, the corrosion of mild steel was decreased 28 per cent. in water with air bubbling through, and 50 per cent. in water with air passing over the surface at atmospheric temperature. The protective effect between atmospheric temperature and 60° C. was only about 16 per cent. Overheated steel was electronegative to the same steel in the normal condition. In distilled water the effect of having brass in contact with steel or cast iron was very slight. The addition of glycerine to water reduced the rate of corrosion to a very low figure. The rate of corrosion of cast iron was practically independent of the manganese content between 0·46 and 3·08 per cent., and of the phosphorus content between 0·072 and 3·38 per cent. A comparison between a mild steel (C 0·04 per cent.), a weld iron (C 0·08 per cent.), and a grey cast iron (C 3·7 per cent.) showed very little difference between the rates of corrosion in the above waters; the cast iron rusted a trifle more rapidly than the others. In 1 per cent. sulphuric acid the relative rates of corrosion of these three metals were as 1 : 2 : 100. Extensive experiments showed that starting with distilled water, as concentration of any salt increases, in general a minimum activity of corrosion occurs followed by a maximum. In individual cases the minimum or the maximum is absent, and sodium nitrate gives two maxima. K_2CO_3 and Na_2CO_3 solutions have such maxima, the rate of corrosion, contrary to generally accepted ideas, being 88 per cent. greater than with water alone. At high concentrations, however, the carbonates have a relatively protective action. Another erroneous view which these results confute is that solutions of the chlorides and sulphates of the alkali metals have a greater corrosive effect than pure water. In the case of certain solutions, an increase of concentration beyond that which gives the max. rate of corrosion, gives a rapid fall until the iron does not corrode at all in the solution. This concentration ("Schwellenkonzentration") depends, in any particular case, upon the exact conditions of the experiment. Chromic acid and its potassium salts are the most markedly non-corrosive, *i.e.*, protective, solutions, in contact with iron, although chromic acid and potassium dichromate solutions of any concentrations are not absolutely non-corrosive. The amount of oxygen in the solution exercises a determinative influence on corrosion, and as the solubility of oxygen in electrolytes in general decreases as the concentration of the electrolyte increases, it would be expected that the rate of corrosion would decrease with increasing concentration in solutions in which this is the case. The initial p.d. between iron electrodes and electrolytes was independent of the lapse of time between the cleaning and the immersion of the iron, but depended greatly on the nature of the actual cleaning process. The later values of p.d. depended on whether the liquid was stirred or not. Stirring raised the potential of the iron in solutions below the "Schwellenkonzentration," and decreased the potential with solutions of higher concentration. Many time-p.d. curves are given. In electrolytes with no "Schwellenkonzentration," and in electrolytes which have, but are below the "Schwellenkonzentration," the p.d. is always algebraically greater than —0·2 volt for any concentration, and increases with lapse of time. In electrolytes above the "Schwellenkonzentration" the p.d. decreases below —0·2 volt. This can be stated thus: If the p.d. is less than —0·2 volt there will be no corrosion. If greater, direct experiment is the surest manner of deciding in a given case as to whether corrosion will occur or not. Immersion in a non-corroding solution does not protect iron against corrosion when later it is immersed in solutions which are normally capable of attacking it. In all cases the amount of corrosion referred to is the loss of weight due to exposure to the solutions.

F. R.

1190. *Investigations relating to the Corrosion of Iron.* **A. Schleicher** and **G. Schultz.** (Stahl u. Eisen, 28. pp. 50–58, Jan. 8, 1908. Communication from the Chem.-techn. Laborat. d. Kgl. techn. Hochschule, München.)—The authors have carried out a series of investigations upon the e.m.f.'s shown by pieces of iron suspended under water and while insulated from each other, connected in circuit with a delicate galvanometer. The observations were made with pieces of clean and of rusty iron, and with both open and closed electrical circuits. The experiments, of which details are given, related to the e.m.f. caused by the amount of corrosion or rust upon the iron, and by the amount of carbon contained in the iron. The first experiment was made with two pieces of rusted wrought iron. The p.d. rises to a considerable height at the moment of immersion, and then falls gradually to the zero line in 90 min. At the end of 60 min. one of the pieces of iron was covered with minute gas-bubbles, while the other was covered with a layer of liquid containing solid particles in suspension, which were slowly settling down to the bottom of the cell. Further investigation showed that the first piece of metal was acting as positive pole and the second as negative pole of the cell, and that as the liquid containing solid matter in suspension increased in volume and diffused through the whole of the cell, the p.d. between the two pieces of metal dropped to the zero line. This experiment was repeated many times, the two pieces of iron being dried in the air between successive tests, and always yielded the same results. The second experiment was carried out with pieces of iron of identical chemical composition, but clean and bright. The curve obtained shows that the p.d. in this case fell nearly to the zero line, 6 min. after immersion, and then slowly rose again to a level nearly equal to that recorded in the first experiment. The fall here corresponded to a change of pole in the cell, and the state of the liquid at the end of 3 hours resembled that noticed in Experiment I. The third experiment was made with one rusted and one clean piece of iron. The curve obtained in this case shows that no change of pole occurred in this experiment, and the clean piece of iron remained kathode during the whole of the period covered by the curve. These experiments prove, in the author's opinion, that the "rusting" of iron must be looked upon as an electrochemical process, since the chemical change is always accompanied by alterations in the potential of the two immersed pieces of iron. If the p.d. is slight or non-existent, both pieces are undergoing oxidation at the same rate, while a large p.d. indicates that one piece is being more rapidly attacked than the other. J. B. C. K.

1191. *Oxidation of Platinum.* **C. Marie.** (Comptes Rendus, 146. pp. 475–477, March 2, 1908.)—Plates of platinum, pure or alloyed with iridium, are found to be acted upon by solutions of persulphate, bichromate, chlorate, and permanganate of potash, in the presence of H_2SO_4, and by alkaline solutions of ferrocyanide and permanganate of potash, an oxide of platinum (PtO_2?) being formed, which is dissociated by heat, and, whilst insoluble in H_2SO_4, has the same solubility in HCl as the electrolytic oxide. [See also Abstract No. 1431 (1907).] W. H. Si.

1192. *Thermochemistry of Electrolytes in Relation to the Hydrate Theory of Ionisation.* **W. R. Bousfield** and **T. M. Lowry.** (Faraday Soc., Trans. 3. pp. 123–139, Oct., 1907. Discussion. Electrician, 59. pp. 594–596, July 26, 1907. Abstract.)—The authors discuss the energy-changes accompanying the ionisation of a salt, and advance the view that the combination of the charged radical or ionic nucleus, $\overset{+}{Na}$, $\overset{-}{Cl}$, $\overset{++}{Mg}$, $\overset{--}{SO_4}$, &c., with water is a powerful exothermic process, and that the affinity of the ionic nucleus for water is the main source of the disruptive force which breaks down or ionises the molecule; the heat liberated in this way is of the same order of magnitude as the heat absorbed by the disruption of the molecule, and the balance may be either a small positive or a small negative quantity. From the known values of the ionic charge and the ionic radius a rough calculation is made of the work required to electrify one equivalent of kathion or anion, on the assumption that the ions may be regarded as charged spheres immersed in a fluid dielectric; for a gm.-equivalent of an ion this work amounts to $27\pi \times 10^9(l/k)$ ergs, where l is the ionic mobility and k the specific inductive capacity of the surrounding medium. This result assumes that the ordinary formulæ for the electrostatic capacity and energy of electrification of a spherical conductor may be applied to the ions, and that the motion of the latter through the liquid is governed by Stokes's law, the ions being spherical and having all the same coefficient of friction. According to the electrolytic dissociation theory, the heat of formation of a salt in a dilute solution is the sum of the heats of formation of the hydrated ions, and by calculating the heats of formation of all the important ions, both positive and negative, the authors find that the heats of formation of the salts in dilute solution are additive quantities; so that, just as there is a law of independent migration of the ions, there is also a law of independent heat of formation of the ions. It is pointed out that no such relationship exists either for the heats of formation of the solid salts or for their heats of solution, nor for the heats of formation of organic compounds. The heat of formation of an ion is the algebraic sum of several distinct energy-changes, which, for the elementary ions, such as $\overset{+}{Na}$, $\overset{++}{Ba}$, $\overset{-}{Cl}$, are: (1) The heat-change involved in the cleavage of the molecules of the element into their separate atoms; (2) the heat-change involved in electrifying these atoms; (3) the heat-change involved in the combination of the charged atoms or ionic nuclei with water. For compound ions, such as $\overset{+}{NH_4}$, $\overset{-}{NO_3}$, there is also (4) the heat-change involved in the combination of the constituent atoms of the radical. As a rule (1) and (2) are endothermic and (3) and (4) exothermic changes. T. H. P.

1193. *Solutions of Metals in Non-metallic Solvents. I. General Properties of Solutions of Metals in Liquid Ammonia.* **C. A. Kraus.** (Amer. Chem. Soc., Journ. 29. pp. 1557–1571, Nov., 1907. Contribution from the Research Lab. of the Massachusetts Inst. of Technology, No. 18.)—The behaviour of non-metallic solvents is examined with respect to their power of dissolving metals. Lithium is soluble in ethylamine and potassium in ethylenediamine. In the higher primary amines and in the secondary and tertiary amines the alkali metals are insoluble. The behaviour of mixed solvents is also studied. As a rule the alkali metals are soluble in any inactive solvent containing a large proportion of ammonia, the solubility increasing with the latter. If sufficient metal is added to a solvent containing ammonia the system generally separates into two liquid phases differing markedly in metal-content and appearance. A similar separation occurs when a salt is added to a solution of a metal in ammonia. Dilute solutions of the compound $NaPb_2$ are electrolytic, the ions $\overset{+}{Na}$ and $\overset{-}{Pb_2}$ being apparently present; the reactions of the compound are in accord with this observation. The solubility curve for sodium in ammonia is given, and it is found that, over a limited range of concentration, two solutions of sodium co-exist, each containing less than 15 per cent. Na; their critical point of solution lies at about -50° and corresponds with 10 per cent. Na. The reaction $Na + NH_3 = NaNH_2 + \frac{1}{2}H_2$ in sealed tubes is studied. The velocity of reaction is nearly constant for some days, after which it is greatly accelerated, probably owing to the catalytic action of solid sodamide, which is precipitated. Contrary to the statement of Joannis (Comptes Rendus, 112. p. 392, 1891), this reaction does not appear to be retarded by the presence of hydrogen gas. T. H. P.

1194. *Electrolytic Conductivity of Bromine and Iodine dissolved in Nitrobenzene.* **L. Bruner.** (Acad. Sci. Cracovie, Bull. 7. pp. 731–738, July, 1907.)—Bromine freshly dissolved in nitrobenzene gave a conducting solution, but not when dissolved in toluene or carbon tetrachloride. The conductivities are small and decrease rapidly with time; the bromine appears to be slowly eliminated by interaction with the solvent, and even the initial conductivity of the solutions seems to be uncertain. Iodine solutions showed still smaller conductivity when dissolved in nitrobenzene and none at all in toluene. [This difference may be ascribed to the ease with which water can be removed from toluene and carbon tetrachloride: nitrobenzene is exceedingly difficult to dry, and the conductivity observed is probably dependent on the moisture present in the solvent.] T. M. L.

1195. *Radium and the Electrolytic Conduction of Colloidal Solutions.* **L. Zlobicki.** (Acad. Sci. Cracovie, Bull. 9. pp. 1009–1016, Nov., 1907.)—Describes experiments on the influence of radium on the conductivity of colloidal solutions. The conductivity was measured by means of the Wheatstone-Kohlrausch bridge. The solutions dealt with were gold and silver solutions in alcohol, water, ether, and xylol. The results show that in the presence of radium the conductivity of the solutions in alcohol, ether, and water is diminished, while the conductivity of the xylol solution is increased.

The effect is not instantaneous, but reaches its maximum in about half an hour, and after the removal of the radium the conductivity reaches its original value in about the same time. A. W.

1196. *Solution in a Dissolved Solid.* **C. L. Parsons.** (Journ. Phys. Chem. 11. pp. 659–680, Dec., 1907.)—Measurements are given of the freezing-point and electrical conductivity of—

Camphor dissolved in water + acetic acid
Iodine „ „ + acetic acid
Iodine „ „ + potassium iodide
Litharge „ „ + lead acetate
Silver cyanide „ + potassium cyanide
Boric acid „ „ + borax

It has usually been assumed that acetic acid merely acts as a solvent in the ordinary way, but that definite complex chemical compounds (KI_3, $KAgC_2N_2$, polyborates, &c.) are formed when the second constituent is a salt which is solid at ordinary temperatures. The author considers that potassium iodide and acetic acid may act in precisely the same way in promoting the dissolution of iodine, and that dissolved solids (to which class even acetic acid belongs at temperatures below 16°) frequently possess solvent powers. In support of his view he shows that the two solutes can frequently be separated by dialysis, although in other cases where complexes are undoubtedly formed this does not occur. [A dissociating complex would, however, diffuse almost as readily as if the constituents were wholly separate.] It is remarkable that in the first four cases the addition of the second solute actually raises the freezing-point of the solution: this is regarded as a general effect when the second solute is insoluble in the solvent, but mixes with the first solute. T. M. L.

1197. *Vapour Pressures of Triethylamine, of* 2 : 4 : 6 *Trimethylpyridine and of their Mixtures with Water.* **R. T. Lattey.** (Chem. Soc., Journ. 91. pp. 1959–1971, and pp. 1971–1973, Dec., 1907.)—The experimental study of the total pressure curves for the mixtures mentioned shows that they conform with the theoretical type. The partial-pressure curves can be calculated by a form of the Duhem-Margules equation. In both cases the curves show a maximum where the compositions of vapour and liquid are identical. At temperatures where the miscibilities of the components are limited there are indications of a second maximum inside the "unreal" parts of the curves. A comparison of the vapour pressures and critical constants of triethylamine and other liquids leads to the belief that the amine is a unimolecular liquid. This is confirmed by a determination of the temperature-coefficient of the molecular surface energy. D. H. J.

1198. *Absorption-velocities between Solids and Gases.* **A. Hantzsch** and **G. Wiegner.** (Zeitschr. Phys. Chem. 61. pp. 475–490, Jan. 21, 1908.)—Under certain conditions the absorption of pure NH_3 gas by solid acids and of pure HCl gas by solid bases proceeds as a "monomolecular" action. When the action takes place in presence of an equimolecular proportion of dilute ammonia or HCl the action proceeds in a few cases as a bimolecular action. No distinction could be detected between pseudo-acids and true acids or between pseudo-bases and true bases, although an additional change is necessary to convert the former into salts. T. M. L.

1199. *Conductivity of Picric Acid Solutions and the Mobility of the Hydrogen Ion.* **H. Gorke.** (Zeitschr. Phys. Chem. 61. pp. 495–502, Jan. 21, 1908. Communication from the Chem. Laborat. d. Univ., Leipzig.)—The limiting value for the molecular conductivity of picric acid was found to be 346 at 18° and 384 at 25°. If the values for the mobility of the picrate ion (deduced from observations of the sodium salt) are deducted from the above figures, the values deduced for the mobility of the hydrogen ion are 320 at 8° and 353 at 25°. A comparison with values deduced from other observations is given in the paper. T. M. L.

1200. *Electrical Conductivity in Mixtures of Acid and Water.* **G. Boizard.** (Soc. Franç. Phys., Bull. No. 3. pp. 303–324, 1907. Journ. de Physique, 7. pp. 119–135, Feb., 1908. Annal. Chim. Phys. 13. pp. 289–361, March, and pp. 433–479, April, 1908.)—If a mixture of sulphuric acid and water is used as a solvent, it is noticed that the conductivity is increased by the addition of an acid base or salt when the proportion of acid to water is very small or very great, but at intermediate concentrations the added electrolyte produces an actual decrease of conductivity. The effects produced by the addition of ammonium, potassium, sodium, and potassium-hydrogen sulphates, acetic acid, and potassium acetate are tabulated and plotted in the form of curves, the increase or decrease of conductivity being shown in relation to the composition of the solvent. The curves for the neutral sulphates and for acetic acid are remarkable in that they exhibit maximum decreases at 2–15 per cent. H_2SO_4 and at 85 per cent. H_2SO_4; those for potassium-hydrogen sulphate and potassium acetate show a maximum decrease in the concentrated solvent at 87 per cent. H_2SO_4; in the dilute solvent the acid sulphate produces an increase of conductivity which tends to a limiting magnitude at 0 per cent. H_2SO_4, whilst the acetate produces a decrease of conductivity which is more and more pronounced as the percentage of sulphuric acid in the solvent decreases, though evidently at extreme dilutions, and in the case of water itself it must produce an increase of conductivity. The conclusion is drawn that the neutral sulphates exist along with the bisulphate in solutions containing up to 15 per cent. H_2SO_4 in the case of the sodium salts, 20 per cent. for potassium and 23 per cent. for ammonium. T. M. L.

1201. *Solutions of Salts exhibiting Negative Viscosity.* **F. H. Getman.** (Amer. Chem. Soc., Journ. 30. pp. 721–737, May, 1908.)—The salts examined were the chloride, bromide, iodide, and nitrate of sodium, potassium, and ammonium, together with rubidium iodide. The conclusion arrived at was that negative viscosity was due to the kathion, which in some cases tended to lower the viscosity of the solvent, whilst the anion and the undissociated molecule tended to increase it. The salts which produce this effect are those whose kathions have a large atomic volume (Jones and Veazey). Negative viscosity is usually most marked at low temperatures, probably owing to the formation of molecular complexes with large volume and small surface, which tend to diminish the viscosity. The product of viscosity and conductivity was only approximately constant for the solutions studied. [Compare Abstract No. 866 (1908).] T. M. L.

1202. *E.M.F. of Concentration Cells.* **H. S. Carhart.** (Phys. Rev. 26. pp. 209–219, March, 1908.)—The author discusses the formulæ of Helmholtz and Nernst, for calculating the e.m.f.'s of concentration cells, and points out several objections to the conclusions of Richards and Forbes from their work entitled "Energy Changes involved in the Dilution of Zinc and Cadmium Amalgams." Carhart and Mellencamp have investigated certain concentration cells in which the heats of dilution are known, and measured the temperature-coefficients of the cells. They obtained a good agreement between the values observed and those calculated for the e.m.f. of the cells. The temperature-coefficients of the concentration cells (different dilutions of $ZnSO_4$, $CdSO_4$, $ZnCl_2$), referred to the observed e.m.f. at zero, gave values widely different from that required by the gas law, viz., 1/273 or 0·00366. The author concludes that the temperature-coefficient is not 0·00366, because the e.m.f. of the cells is not in any case proportional to the absolute temperature. F. J. B.

1203. *Variations of Electromotive Force in Concentration Cells.* **P. Girard.** (Comptes Rendus, 146. pp. 927–929, May 4, 1908.)—If two solutions of different concentrations of an electrolyte were connected through a diaphragm of chloride of chromium or calcined alumina, the measured potential was always lower than that found when the diaphragm was absent. For example, in the concentration cell $\frac{N}{10}HCl//\frac{N}{500}HCl$ the measured e.m.f. was 0·060 volt without a diaphragm and 0·024 volt with a diaphragm of $CrCl_3$ interposed. When cells of various concentrations of salts of di- and tri-valent elements and radicals were used, the differences between the e.m.f. with and without a diaphragm became less. The author gives a provisional theory of this phenomenon, which he ascribes to the polarisation of the diaphragm interposed. F. J. B.

1204. *New Apparatus for measuring Electrolytic Resistance.* **A. W. Smith.** (Science, 27. pp. 635–636, April 17, 1908. Paper read before the Amer. Assoc. for Advancement of Science and the Amer. Physical Soc., Chicago, Dec. 31, 1907.)—The apparatus consists of a strong glass tube provided with a small side tube for filling. Both ends are ground plane and closed by platinum-faced electrodes, the whole being firmly clamped together in a suitable framework. Crushing strains, due to the unequal contraction of glass and metal, are avoided by the use of heavy rubber washers, one on each side, which take up the extra length without much increase in pressure. The apparatus cannot be used for refined measurements, but it is a very convenient one for demonstrating to a student the meaning and significance of the molecular conductivity of an electrolyte. T. S. P.

1205. *Electrolytic Valve Action of Zinc and Cadmium.* **G. Schulze.** (Ann. d. Physik, 26. 2. pp. 372–392, June 9, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—Zinc shows in dilute K_2CO_3 a valve effect similar to that of the other metals (Al, Mg, &c.). From 10 to 30 per cent. is the concentration at which the effect is most marked, the max. voltage withstood ranging from 88 to 54 volts for the upper and lower limits of concentration. The effect of temperature is not very pronounced, the max. voltage falling only from 88 at 0° C. to 64 at 80° and about 49 at 100°. Cadmium shows a similar effect in the same electrolyte, but the influence of concentration is more marked than with zinc (125 volts max. at 1 per cent., 82 volts at 10 per cent.); the influence of temperature is also more noticeable (127 volts at 0°, 20–45 volts at 50°, 10–30 volts at 100°). Neither zinc nor cadmium can, however, be used with alternating currents, since the reverse half-wave causes a peeling of the "skin." The author gives oscillograms obtained with alternating currents by the device consisting in using another valve electrode to cut off the undesired half-waves. Thus a Zn or Cd electrode in K_2CO_3 was opposed to an Al electrode in ammonium borate, in a separate cell, but the two electrolytes being connected by means of a Pt wire dipping into both cells. In this way the Zn and Cd electrodes "formed" even with alternating currents. The behaviour of silver and copper in various electrolytes was also examined; the effect obtained is, however, not due to a gas layer but to a solid film. L. H. W.

1206. *A Silver Micro-voltameter.* **E. Bose** and **F. Conrat.** (Zeitschr. Elektrochem. 14. pp. 86–88, Feb. 21, 1908. Physikal.-chem. Laborat. d. techn. Hochschule, Danzig-Langfuhr, Jan., 1908.)—The kathode of the micro-voltameter consists of a short length of Pt wire, which is hooked on to another Pt wire in order to connect it to the source of current. The wire is weighed, before and after the experiment, on a Nernst micro-balance. The results are accurate to within 0·25–0·56 per cent., the weight of silver deposited varying from 0·5 to 2 mgm. The authors use the voltameter to show that the electrochemical equivalent of silver, as determined with a solution of silver nitrate, is about 2 per cent. too high at 95°, owing to the fact that silver dissolves in silver nitrate solution with the formation of $Ag_2^{\cdot}$-ions. T. S. P.

1207. *Electrolytic and Chemical Action of Ammonium Persulphate on Metals.* **J. W. Turrentine.** (Amer. Electrochem. Soc., Trans. 12. pp. 297–305, 1907.)—When a persulphate is decomposed in presence of an insoluble anode or in the absence of an anode, oxygen is evolved, as may be seen on mixing concentrated sulphuric acid with saturated ammonium persulphate solution containing excess of the persulphate crystals and a little manganese sulphate as catalyst. If this liberation of sulphate ions is analogous to that produced by the electrolysis of a sulphate solution, a soluble metal should be completely dissolved by persulphate solutions. Experiments made with Cu, Ni, Cd, Al, and Fe yield the following results. Copper in ammonium persulphate solutions behaves just as does a copper anode in the electrolysis of sulphates. Nickel, Cd, and Al bear ou the analogy between the chemical corrosion in ammonium persulphate and the electrolytic corrosion in ammonium sulphate. Iron is dissolved by persulphates, and partly appears subsequently as ferric sulphate, being oxidised by the persulphate in solution; the free acid formed by the hydrolysis of ferric sulphate acts as a catalytic agent in the reaction between iron and water. T. H. P.

1208. *Electrolytic Reduction of Nitric Acid.* **H. E. Patten.** (Amer. Electrochem. Soc., Trans. 12. pp. 325–398, 1907.)—When nitric acid is reduced electrolytically in presence of sulphuric acid, a copper kathode and a porous diaphragm being used, the yield of ammonia increases whilst that of hydroxylamine decreases as the concentration of the sulphuric acid is augmented. Increase of current density decreases the yield of ammonia when a Cu kathode is employed, but increases the yield in the case of a Pt kathode. The yields of ammonia and hydroxylamine are only slightly influenced by ordinary changes in the temperature. The yield of ammonia is greatly increased by the continued deposition of Cu at the kathode, but Tafel's suggestion that this effect is due to a catalytic action of the deposited spongy Cu is questionable, since the same effect is produced when Cu is continually deposited upon an amalgamated Cu kathode, which retains a smooth surface. In general, a low kathode discharge accompanies a high yield of ammonia if the current density remains unchanged. Hydroxylamine probably represents an intermediate stage in the reduction of nitric acid to ammonia by means of a Cu kathode. T. H. P.

1209. *Decomposition Potential of Molten Calcium Chloride.* **K. Arndt** and **K. Willner.** (Zeitschr. Elektrochem. 14. pp. 216–218, April 17, 1908. Elektrochem. Laborat. d. techn. Hochschule, Charlottenburg, March 26, 1908.)—The decomposition potential of molten calcium chloride was determined by measuring the back e.m.f. of the decomposition cell. After electrolysing the melt for some time the current was broken by means of a commutator, and the back e.m.f. measured by compensation against a known voltage. The measurement had to be made very quickly, since the polarisation of the cell rapidly diminished when the current was broken. The anode was of carbon, and the kathode either of iron, nickel, or copper wire, or else molten lead or tin. At 800° C. the decomposition potential was found to be 3·25 volts. This was verified by measuring the e.m.f. of the cell: metallic calcium/molten calcium chloride/chlorine gas, for which the value 3·2 volts was obtained. It was not possible to measure the temperature coefficient of the cell, since calcium readily forms a kathode fog. The decomposition potential of molten strontium chloride at 880° C. was similarly found to be 3·40 volts; that of molten barium chloride was 3·8 volts, but this value is certainly too low. T. S. P.

REFERENCES.

1210. *Atomic Weights of Nitrogen, Oxygen, and Carbon.* **A. Leduc.** (Comptes Rendus, 146. pp. 399–400, Feb. 24, 1908.)—On the basis of the value 14·01 (O = 16) given as the atomic weight of nitrogen by the International Committee on Atomic Weights, and the values obtained by the author and by Rayleigh for the ratio of the molecular volumes of carbonic oxide and nitrogen, the atomic weight of carbon is calculated to be 12·016–12·011. T. H. P.

1211. *Relation between Compressibility, Surface Tension, and other Properties of Material.* **T. W. Richards** and **J. H. Mathews.** (Amer. Chem. Soc., Journ. 30. pp. 8–13, Jan., 1908.)—In this preliminary paper are given a number of new results on the compressibility, surface tension, boiling-point, specific gravity, and water pressure at 20° of a number of organic substances. It is shown that approximate relationships exist between some of these quantities, particularly that as a rule substances with large surface tension possess small compressibility. This relationship is discussed briefly from the point of view of the theory of compressible atoms. T. H. P.

1212. *Physico-Chemical Studies on the so-called "Amorphous Antimony."* **E. Cohen** and **J. Olie.** (Zeitschr. Phys. Chem. 61. pp. 588–595, Jan. 31, 1908. Van't Hoff Laborat., Utrecht, Oct., 1907.)—Hérard, in 1888, announced the formation of an allotropic amorphous form of antimony by passing nitrogen over the heated metal; the authors have repeated the experiments and find the announcement to be erroneous, and due to the use of imperfectly purified material. D. H. J.

1213. *Supposed Presence of Microscopic Diamonds in a Marine Deposit and in a Sample of Soil.* **J. Thoulet.** (Comptes Rendus, 146. pp. 351–352, Feb. 17, 1908.)—Small grains of high density and refractive index were isolated from a marine deposit and from a sample of soil, but the quantities isolated were too small to admit of analysis. T. M. L.

1214. *Physico-Chemical Studies on the so-called "Amorphous Bismuth."* **E. Cohen** and **J. Olie.** (Zeitschr. Phys. Chem. 61. pp. 596–598, Jan. 31, 1908. Van't Hoff Laborat., Utrecht, Oct., 1907.)—Hérard's conclusion (1888) that he had obtained an allotropic modification of bismuth by heating the metal in nitrogen is shown to be erroneous; his supposed modification was merely ordinary Bi containing more or less bismuth trioxide: the presence of the oxide was due to the use of impure materials. D. H. J.

1215. *Electric Smelting of Tin Ores.* **F. Mattonet.** (Metallurgie, 5. pp. 186–191, March 22, 1908. Communication from the Inst. f. Metallhüttenw. and Elektrometall. d. kgl. techn. Hochschule, Aachen.)—Gives a description of a method of smelting tin ores in a resistance furnace, with analyses of slags, &c. Compares results with those obtained by other smelting methods, and discusses the refining of the tin obtained. C. O. B.

1216. *Amalgam Concentration Chains, Chemical Chains, and Daniell Chains with Solid Electrolytes.* **M. Katayama.** (Zeitschr. Phys. Chem. 61. pp. 566–587, Jan. 31, 1908. Laborat. f. physikal. Chemie. u. Elektrochemie am eigd. Polytechnikum, Zürich.)—The e.m.f. of three types of chains with solid electrolytes was measured. The types were: (1) Amalgam concentration chains such as: Lead amalgam | lead bromide | lead amalgam; (2) chemical chains of the form: metal | electrolyte | halogen; (3) Daniell chains of the form: metal I | electrolyte I | electrolyte II | metal II. The results are given in a series of tables, and the values agree closely with those calculated from the Nernst formula for concentration chains. D. H. J.

1217. *Molecular Weight of Radium Emanation.* **P. B. Perkins.** (Amer. Journ. Sci. 25. pp. 461–473, June, 1908. Contribution from the Sloane Physical Laborat. of Yale Univ.)—By comparing the rate of diffusion of radium emanation with that of mercury vapour, the author finds that the emanation has an atomic weight near to that of radium—a result which the disintegration theory would indicate, but which previous diffusion experiments had not confirmed. T. H. P.

1218. *Nomenclature of Iron and Steel.* (Amer. Inst. Mining Engineers, Bull. 20. pp. 227–237, March, 1908. Committee Report of International Assoc. for Testing Materials, presented at Brussels Congress, 1906.)—The report consists of four parts: (1) A table giving the names of the chief classes of iron and steel and of the apparatus in which they are made, in English, French, German, Swedish, Danish, and Dutch; (2) definitions of principal classes of iron and steel; (3) glossary of special sizes and shapes of iron and steel; (4) a note on the boundary between steel and iron. Under heading (4) two proposals are considered: (*a*) That the point 0 in the Roberts-Austen-Roozeboom diagram, *i.e.*, 0·32 per cent. carbon, be the limit between steel and iron, and (*b*) to draw the line at 0·2 per cent. carbon. In a footnote, **Pourcel** would classify according to presence or absence of slag. F. R.

1219. *The Entropy Function in the Conversion of Chemical into Electrical Energy.* **E. Kohl.** (Ann. d. Physik, 25. 1. pp. 155–174, Jan. 17, 1908.) A. F.

1220. *Repetition of de Heen's and Teichner's Experiments on the Critical State.* **H. Kamerlingh Onnes** and **G. H. Fabius.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 215–230, Oct. 31, 1907. Communication No. 98 from the Phys. Lab., Leiden.)—Paper unsuitable for abstraction. F. J. B.

1221. *Combinations of Silver Selenide with the Selenides of Arsenic, Antimony, and Bismuth.* **H. Pélabon.** (Comptes Rendus, 146. pp. 975–977, May 11, 1908.)—A study of the fusibility of mixtures of Ag_2Se with As_2Se_3, Sb_2Se_3, and Bi_2Se_3, indicates the formation of three compounds corresponding to the formulæ $3Ag_2Se, 4As_2Se_3$, $3Ag_2Se, 4Sb_2Se_3$, and $3Ag_2Se, 4Bi_2Se_3$. W. H. Si.